STAR

Scientific and Technical Aerospace Reports

A SEMIMONTHLY ABSTRACT JOURNAL WITH

SEPTEMBER 23, 1967

VOLUME 5 • NUMBER 18

N67-31499—N67-32698

DOCUMENTS DEPT.

OCT 4 1967

Duke University

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PURCHASE OF *STAR*

The semimonthly issues and the cumulative index issues are available postpaid on subscription and in single copy from the Superintendent of Documents, United States Government Printing Office, Washington, D.C., 20402, United States of America.

Semimonthly issues . . .

Annual subscription rate: $33.00, domestic; $42.00, foreign. Price per single copy: $2.25, domestic; 25¢ extra for foreign mailing.

Cumulative index issues . . .

Annual subscription rate: $30.00, domestic; $35.00, foreign. Price per single copy varies according to the number of pages.

Domestic subscription rates . . .

Apply to the United States, Canada, Mexico, and all Central and South American countries, except as noted below.

Foreign subscription rates . . .

Apply to Argentina, Brazil, British and French Guiana, Surinam, British Honduras, and all other countries throughout the world.

Payment should be by check, money order, or document coupons, and must accompany order. Remittances from foreign countries should be made by international money order, or draft on an American bank, payable to the Superintendent of Documents, or by UNESCO book coupons.

PUBLISHED BY:
UNITED STATES GOVERNMENT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SCIENTIFIC AND TECHNICAL INFORMATION DIVISION

Scientific and Technical Aerospace Reports, Volume 5, is prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Documentation Incorporated.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 7, 1966.

Introduction

WHAT *STAR* IS

Scientific and Technical Aerospace Reports (STAR) **is a comprehensive abstracting and indexing journal covering worldwide report literature on the science and technology of space and aeronautics. It is published twice each month.**

Major areas covered in *STAR* are:

Scientific and technical reports of the National Aeronautics and Space Administration and its contractors; scientific and technical reports of government agencies, universities, and research organizations throughout the world.

HOW *STAR* IS ORGANIZED

The first section of *STAR*, arranged in 34 categories, contains abstracts and bibliographic citations. A second section consists of five indexes: subject, author, source, report/accession number, and accession/report number. Separate cumulative indexes are published quarterly, the fourth quarterly being an annual index for the calendar year. Cumulative indexes also contain a contract number index.

HOW TO USE *STAR*

Readers are encouraged to examine the abstracts in each category of interest. If time is short, and when interest is concentrated in specific areas, readers may wish instead to scan source, author, and subject indexes. A more thorough coverage of a subject field may often be achieved by detailed examination of the subject listings, especially as they are cross-indexed in the quarterly indexes.

AVAILABILITY OF *STAR* AND DOCUMENTS

NASA documents (identified by an asterisk), as well as *STAR* itself, are available without charge to:

1. **NASA Offices, Centers, contractors, subcontractors, grantees, and consultants.**
2. **Other U.S. Government agencies and their contractors.**
3. **Libraries in the United States that maintain collections of NASA documents for public reference.**
4. **Other organizations in the United States having a need for NASA documents in work related to the aerospace program.**
5. **Foreign government or academic (university) organizations that have established reciprocal arrangements for the exchange of publications with NASA, that have current agreements for scientific and technical cooperative activities with NASA, or that have arrangements with NASA to maintain collections of NASA documents for public use.**

Department of Defense documents (identified by the "AD" number in the citation) are available without charge to U.S. Government-sponsored research and development activities from the Defense Documentation Center (DDC), Cameron Station, Alexandria, Virginia 22314. Department of Defense documents are not available from NASA.

Other non-NASA documents are provided by NASA without charge only to NASA Offices, Centers, contractors, subcontractors, grantees, and consultants. Foreign non-copyrighted documents will be provided to U.S. Government Agencies and their contractors. AGARD reports that are not commercially available will be made available on the same basis as NASA documents.

Documents that have been placed on microfiche are identified with the symbol #. Microfiche are available on the same basis as hard-copy.

HOW TO REQUEST LISTED DOCUMENTS

If you are registered with NASA, send a completed *Document Request* (Facility Form 492) to:

NASA Scientific and Technical Information Facility
P. O. Box 33
College Park, Maryland 20740

If you are not registered with NASA, but are eligible to receive documents without charge according to the information on the previous page in the section on Availability of *STAR* and Documents, request Registration Form—Technical Publications (Facility Form 713) from the above address.

HOW THE PUBLIC MAY OBTAIN LISTED DOCUMENTS

For reference purposes, NASA documents listed in *STAR* may be consulted at one of the organizations listed on the inside back cover. Commercial publications listed in *STAR* may be consulted in libraries or purchased from publishers or booksellers.

The public may purchase NASA documents and non-copyrighted foreign documents listed in *STAR* from either of two sales agencies, specifically identified in the abstract section:

Clearinghouse for Federal Scientific and Technical Information
(CFSTI)
Springfield, Virginia 22151

Superintendent of Documents, U. S. Government Printing Office
(GPO)
Washington, D. C. 20402

Documents available from CFSTI are sold in hard copy and microfiche form. If a printed hard copy is not available, a facsimile copy is provided. The symbols "HC" and "MF" are used in the abstract section to designate the copy available: "HC" (hard copy) for full size or facsimile; "MF" for microfiche. A unit price policy has been established by CFSTI: $3.00 for printed hard copy or facsimile copy; $0.65 for microfiche.

Not all NASA documents, however, are subject to this policy. Documents available from Superintendent of Documents which are also available from CFSTI are sold at the Superintendent of Documents price, and other selected NASA publications will continue to be priced according to previous practices. In all cases, the *STAR* citation includes the specific sale price which applies.

Following the availability information in the citation of each NASA-supported document is a code, e.g., CSCL 25A, indicating the subject category assigned to that document from the *COSATI Subject Category List* (first ed., December, 1964) published by the Committee on Scientific and Technical Information of the Federal Council for Science and Technology.

The public may request non-NASA documents by writing to the source or other information systems. Identification other than the NASA accession number (i.e., N67-12345) should always be provided when requesting such a document from its source.

ABSTRACTS OF JOURNAL ARTICLES

By arrangement between NASA and the American Institute of Aeronautics and Astronautics, the AIAA publication *International Aerospace Abstracts* is issued in coordination with *STAR*. Each journal appears on alternate weeks. *IAA* uses subject categories identical with those in *STAR*, and publishes similar indexes. *IAA's* worldwide coverage of books and scientific and trade journals complements *STAR's* worldwide report coverage. The two publications thus provide comprehensive access to current literature on aerospace science and technology.

Organizations having a NASA contract may obtain *IAA* by writing NASA, Code USS-A Washington, D. C. 20546. Others should direct inquiries to the American Institute of Aeronautics and Astronautics, 750 Third Avenue, New York, N. Y. 10017.

01 A

02 A

03 A

04 I

05

06

07

08

Volume 5 Number 18 / September 23, 1967

TABLE OF CONTENTS

Subject Categories

Abstracts in the journal are grouped under the following categories:

page

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion. **3185**

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **3190**

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems. **3196**

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology. **3201**

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **3216**

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants. **3220**

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **3228**

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics. **3235**

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation. **3240**

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories. **3252**

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations. **3254**

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion. **3258**

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences. **3260**

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras. **3269**

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, reliability; drafting; and materials fabrication, handling, and inspection. **3273**

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State. **3277**

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see : 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics. **3278**

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics. **3282**

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers. **3284**

20 METEOROLOGY
Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences. 3289

21 NAVIGATION
Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications. 3292

22 NUCLEAR ENGINEERING
Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems. 3292

23 PHYSICS, GENERAL
Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics, 20 Meteorology, and 29 Space Radiation. 3304

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR
Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation. 3307

25 PHYSICS, PLASMA
Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems. 3312

26 PHYSICS, SOLID-STATE
Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics. 3315

27 PROPELLANTS
Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems. 3319

28 PROPULSION SYSTEMS
Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants. 3319

29 SPACE RADIATION
Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear. 3321

30 SPACE SCIENCES
Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles. 3323

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics. **3338**

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic. **3347**

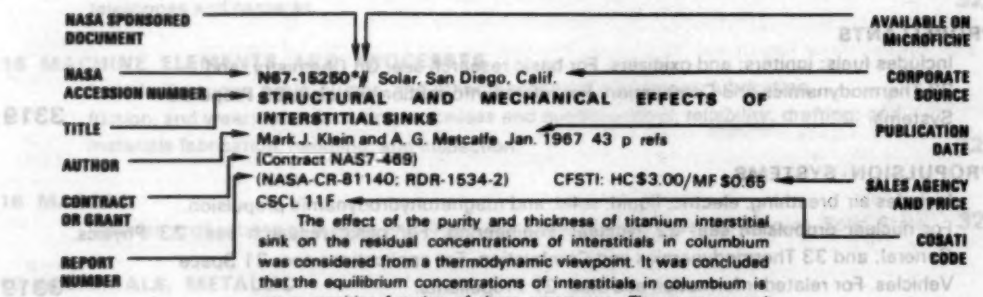
33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants. **3353**

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents. **3357**

TYPICAL CITATION AND ABSTRACT FROM *STAR*


NASA SPONSORED DOCUMENT
AVAILABLE ON MICROFICHE
NASA ACCESSION NUMBER
N67-15250*# Solar, San Diego, Calif.
CORPORATE SOURCE
TITLE
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
PUBLICATION DATE
AUTHOR
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
CONTRACT OR GRANT
(NASA-CR-81140; RDR-1534-2) CFSTI: HC $3.00/MF $0.65
SALES AGENCY AND PRICE
CSCL 11F
COSATI CODE
REPORT NUMBER
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

VOLUME 5, NUMBER 18 / SEPTEMBER 23, 1967

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

N67-31504# Max-Planck-Institut für Stromungsforschung, Gottingen (West Germany).

THREE-COMPONENT MEASUREMENTS ON RECTANGULAR WINGS WITH CAVITATION Final Report

H. Reichardt and W. Sattler Mar. 1967 65 p refs

(Contract N62558-3720)

(AD-652393) CFSTI: HC $3.00/MF $0.65

Investigations of three-dimensional effects in non-cavitating and cavitating flow past rectangular flat plates are reported. Five rectangular wing models with aspect ratios AR = 1.01; 1.5; 2.25; 2.49; and 3.12 were tested. Lift, drag, and pitching moment acting on these models were measured, and the characteristic development of cavities for several flow conditions were photographically recorded. To the extent that measurements of other authors on cavitating hydrofoils were available, these results were used for comparison and supplementation of this work. Values according to the theory of T. Y. Wu (J. Fluid Mech. v13 pt2 p161 1962) about two-dimensional fully cavitating flows were converted into values for a wing with finite aspect ratio and were compared with experimental data. The investigation was performed in a new cavitation tunnel with a free-jet directed vertically upward. Design and performance of the new tunnel are described. Author (TAB)

N67-31546*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

AN INVESTIGATION OF SUPERSONIC STORE INTERFERENCE IN THE VICINITY OF A 22° SWEPT-WING–FUSELAGE CONFIGURATION AT MACH NUMBERS OF 1.61 AND 2.01

Douglas J. Geier Washington, NACA, 24 Feb. 1958 106 p refs (NACA-RM-L57L18) CFSTI: HC $3.00/MF $0.65 CSCL 01A (Declassified)

An investigation has been conducted at the Langley 4- by 4-foot supersonic pressure tunnel in which separate forces and moments were measured on a detached store (five components) in the presence of a 22° swept wing and a 22° swept-wing-fuselage combination (three components) for a wide range of store positions. The configuration presented herein represents a heavy bomber-type airplane with a large symmetrical store. The results are compared to similar tests of a 45° swept-wing–fuselage combination and a 60° delta-wing–fuselage combination. Author

N67-31613*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ANALYSIS AND CORRELATION OF AIRCRAFT WAVE DRAG

Roy V. Harris, Jr. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 153–163 refs (See N67-31606 18-02)

Two approaches are discussed: The first approach is to compare the aircraft area distribution with the slender-body-theory optimum, and the second approach employs the supersonic area rule to determine the equivalent-body area distribution. Although the optimum-body wave-drag variations can be used to indicate the gross trends in aircraft wave drag with equivalent-body fineness ratio and the degree of afterbody closure, the relatively large amount of scatter in the correlating data, due to deviations in aircraft area distributions from the optimum, indicates that more precise computing techniques are required in order to estimate the aircraft wave-drag levels. Several computer programs have been developed which apply the slender-body theory in combination with the supersonic area rule to the solution of aircraft wave drag. Author

N67-31614*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

APPLICATION OF WING WARP AND AERODYNAMIC INTERFERENCE TO IMPROVE SUPERSONIC PERFORMANCE

Francis E. McLean and Harry W. Carlson *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 165–176 refs (See N67-31606 18-02)

A brief review is made of current information on highly swept warped-wing arrangements obtained from experiments with isolated wings, with wing-body configurations, and with complete configurations. The use of analytical methods for the solution of arbitrary planform problems is discussed. Author

N67-31615*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STUDIES OF SKIN FRICTION AT SUPERSONIC SPEEDS

K. R. Czarnecki, Mary W. Jackson, and William J. Monta *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 177–189 refs (See N67-31606 18-02)

A brief review was made of the most significant results from recent research on turbulent boundary layers applicable to the supersonic transport. The review indicates that: High Reynolds number flat-plate boundary-layer skin friction with heat transfer will tend to agree with the predictions of the reference temperature T* method and those theories or methods which are in approximate agreement with this T* method. Three-dimensional boundary layer flow probably will increase skin-friction drag over that expected

from two-dimensional flat-plate theories or experiment. In general, local flow conditions and the proper correlating parameters will have to be used for the accurate prediction of drag due to surface roughness.
Author

N67-31616*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SOME FACTORS AFFECTING TURBULENT SKIN FRICTION AT SUPERSONIC SPEEDS
Albert L. Braslow, John B. Peterson, Jr., and Donald I. McRee *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 191–202 (See N67-31606 18-02)

Preliminary results are presented for two investigations at Mach 3: An investigation of the use of air injection into the turbulent boundary layer through rearward-facing inclined flush and step -slots to reduce skin friction, and an investigation of the contribution to skin-friction drag of three-dimensional roughness trips used to fix boundary layer transition.
Author

N67-31727*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF VARIABLE GEOMETRY GUIDE VANES AND STATORS. PART II: ANNULAR CASCADE INVESTIGATIONS OF CANDIDATE VARIABLE GEOMETRY DESIGNS
14 Jul. 1967 58 p refs
(Contract NAS3-7604)
(NASA-SR-54555; PWA-FR-2297) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Tests were conducted in an annular cascade tunnel to (1) evaluate the feasibility of using a slot near the leading edge of a stator to aid flow turning at high positive incidence angles, and to (2) provide comparative performance data for two candidate variable geometry inlet guide vane designs. The stators were tested at an incidence angle of 14.1 degrees. A slot located at 22.5% chord improved the suction surface diffusion. The best slot configuration tested reduced the wake loss coefficient from 0.224 without a slot to 0.177. A variable geometry guide vane with articulated flaps had the lowest loss coefficient (0.021) in the zero-prewhirl position.
Author

N67-31739*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
THE EFFECT OF TRAILING-EDGE CONTROL DEFLECTION ON THE LOADING OVER A 60° DELTA-WING–BODY COMBINATION
Leland B. Salters, Jr. and Charles E. Mercer Washington, NASA, Oct. 1959 155 p refs
(NASA-TM-X-122) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

An investigation has been made in the 16-foot transonic tunnel to determine the influence of wing trailing-edge constant-chord control deflection on the aerodynamic loading characteristics of a 3-percent-thick 60° delta wing–body combination. The chord length of the control was 15 percent of the mean aerodynamic chord. The control deflections varied from 15° to −15° in 7.5° increments with angles of attack up to 26°. The Mach number range was 0.80 to 1.05 and the Reynolds number was approximately 10×10^6.
Author

N67-31807 Lockheed Missiles and Space Co., Sunnyvale, Calif.
INVESTIGATION OF THE BASE PRESSURE NEAR THE TRAILING EDGE OF AXISYMMETRIC BODIES IN SUPERSONIC FLOW
Iu. A. Panov and A. I. Shvets [1966] 7 p refs Transl. into ENGLISH from Prikl. Mekh., Akad. Nauk Ukr. RSR (Kiev), v. 2, no. 6, 1966 p 105–111

Technical data are presented on experimental wind tunnel investigations of the base pressure and the stream parameters near the trailing edge of axisymmetric smallspan models with blunt nose sections of various shapes. The Reynolds numbers were computed by means of the flow parameters at the outer boundary of the boundary layer and a linear dimension equal to the distance between the forward stagnation point and the trailing edge of the model.
R.U.

N67-31814*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
PRESSURE MEASUREMENTS ON A HYPERSONIC GLIDE CONFIGURATION HAVING 79.5° SWEEPBACK AND 45° DIHEDRAL AT A MACH NUMBER OF 4.95
Morton Cooper and Charles R. Gunn Washington, NASA, Nov. 1959 15 p refs
(NASA-TM-X-223) CFSTI: HC $3.00/MF $0.65 CSCL 01A
(Declassified)

An experimental study of the pressures on a hypersonic glide configuration having 79.5° sweepback and 45° dihedral has been conducted at a Mach number of 4.95 and a Reynolds number of 15.7×10^6 based on body length. The angles of attack of the configuration referenced to the plane of the upper surface were 0°, 5°, and 10°. The pressures on the lower surface in the plane of symmetry approached the pressure that would exist on a swept infinite cylinder within a distance from the apex of about 7 nose diameters—the nose diameter in the plane of symmetry being used as the reference. Because of the low range of crossflow Mach numbers in the present investigation, 0.92 to 1.75, no adequate prediction of the pressures elsewhere could be made by either modified Newtonian or modified tangent-wedge approximations.
Author

N67-31850*# National Aeronautics and Space Administration, Washington, D. C.
THE FLOW OF AIRFOIL PROFILES WITH BLOWING OUT FROM A NOSE SLOT [DIE STROEMUNG AN FLUEGELPROFILEN MIT AUSBLASEN AUS EINEM NASENSPALT]
W. Wuest May 1967 43 p refs Transl. into ENGLISH of an Aerodynamische Versuchsanstalt Report, Goettingen, West Germany, Aug. 1966 p 1–44
(NASA-TT-F-10906) CSCL 01A

On two symmetric airfoil models with nose slots, pressure, temperature, and velocity distributions with the blowing out of cold or hot air were measured in the boundary-layer wind tunnel. Both models had the same constant-pressure nose profile, but one airfoil was unswept and the other had a sweep angle of 65°. The measurements were extended to angles of attack of −10°, 0°, and 10° and free stream velocities from 12 to 40 m/sec, the rate of blowing out being constant.
Author

N67-31960*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
AN EXPERIMENTAL PRESSURE-DISTRIBUTION INVESTIGATION OF INTERFERENCE EFFECTS PRODUCED AT A MACH NUMBER OF 3.11 BY WEDGE-SHAPED BODIES LOCATED UNDER A TRIANGULAR WING
Lowell E. Hasel Washington, NASA, Oct. 1959 116 p refs
(NASA-TM-X-76) CSCL 01A
(Declassified)

The effects of the basic variables of wedge angle and height, of internal air flow, and of modifications to the basic shapes were studied by measuring and integrating the pressures on the bodies and on the bottom wing surface. The use of the basic wedge-shaped bodies under the wing did not increase the maximum lift-drag ratio above that of the wing alone, even when the base-pressure drag was neglected. Modification of the basic body shape resulted in some improvement of the maximum lift-drag ratio, but the performance of the wing alone apparently could be exceeded only by the use of relatively small bodies.
Author

N67-31968*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SPAN LOADINGS AND AERODYNAMIC CHARACTERISTICS FOR A SERIES OF TIP AND TRAILING-EDGE CONTROLS ON A 60° DELTA WING AT MACH NUMBERS OF 1.61 AND 2.01
K. R. Czarnecki and Douglas R. Lord Washington, NASA, Sep. 1959 11 p refs
(NASA-TM-X-51) CSCL 01C (Declassified)

An investigation has been made at a Reynolds number of 4.2×10^6 to determine the span-loading and control-effectiveness characteristics of a series of 20 controls on a 60° delta wing. Tests were made at wing angles of attack from 0° to 15° for control deflections from −30° to 30°. Results are presented to show the effects of Mach number and various types of fences on the experimental span loadings. Control-effectiveness characteristics are presented for those configurations which were not previously reported. A correlation of these control-effectiveness characteristics on the basis of control area and area-moment ratios is included. A comparison is made of the experimental results with those predicted by linear theory. Author

N67-31970*# Boeing Co., Renton, Wash. Airplane Div.
A METHOD OF OPTIMIZING CAMBER SURFACES FOR WING-BODY COMBINATIONS AT SUPERSONIC SPEEDS. PART I: THEORY AND APPLICATION
F. A. Woodward and J. W. Larsen Oct. 1965 219 p refs
(Contract NAS2-2282)
(NASA-CR-69181; D6-10741, Pt. I, Vol. 1) CSCL 01A

A numerical method for the analysis of wing-body combinations, and for the design of optimum wing camber surfaces in the presence of a body is presented. The method is based on the linearized theory of supersonic flow. The wing and body are represented by a large number of singularities located in the plane of the wing, on the surface of the body, and along the body axis. The velocity components induced by these singularities at selected control points define a matrix of aerodynamic influence coefficients. The aerodynamic matrix is used to calculate the pressure distribution on the wing and body for given boundary conditions, or to determine the wing camber surface corresponding to a given aerodynamic loading. Also, the wing camber surface required to minimize the drag of the wing-body combination under given constraints of lift and pitching moment is determined by additional operations on the aerodynamic matrix. The method has been programmed for a digital computer. A special effort has been made to minimize the number of geometrical inputs required in the program by including a geometry definition section and a geometry paneling section as integral parts. Author

N67-31971# Aeronautical Research Council (Gt. Brit.).
SOME EARLY EXPERIMENTS ON VORTEX SEPARATION. PART I: SOME LOW SPEED AERODYNAMIC PROPERTIES OF CONES. PART II: SOME LOW SPEED EXPERIMENTS WITH 20° DELTA WINGS. PART III: FURTHER EXPERIMENTS WITH 20° DELTA WING
P. T. Fink and J. Taylor 1967 51 p refs
(RAC-R&M-3499) HMOS: 19s 6d

CONTENTS:

1. SOME LOW SPEED AERODYNAMIC PROPERTIES OF CONES P. T. Fink p 1–18 refs (See N67-31972 18-01)

2. SOME LOW SPEED EXPERIMENTS WITH 20 DEG. DELTA P. T. Fink and J. Taylor p 17–38 refs (See N67-31973 18-01)

3. FURTHER EXPERIMENTS WITH 20 DEG. DELTA WINGS P. T. Fink p 39–47 refs (See N67-31974 18-01)

N67-31972# Aeronautical Research Council (Gt. Brit.).
SOME LOW SPEED AERODYNAMIC PROPERTIES OF CONES. PART I
P. T. Fink *In its* Some Early Expt. on Vortex Separation 1967 p 1–18 refs (See N67-31971 18-01)

The results are presented of some low speed wind tunnel tests on a right circular cone with apex angle 20 deg and on elliptic cones with apex angles 60 deg and 20 deg. The experiments included balance tests, measurements of pressure distribution, and a limited amount of flow visualization with tufts. The emphasis of the work was on the range of angles of incidence for which viscous effects were appreciable. Symmetric and asymmetric vortex arrangements were found over the suction side of the right circular cone. Author

N67-31973# Aeronautical Research Council (Gt. Brit.).
SOME LOW SPEED EXPERIMENTS WITH 20 DEG. DELTA. PART II
P. T. Fink and J. Taylor *In its* Some Early Expt. on Vortex Separation 1967 p 17–38 refs (See N67-31971 18-01)

The results are presented of some low speed wind tunnel tests on two delta wings with sharp leading edges which have 80 degrees sweepback. Leading edge separation and vortex formation on the suction sides of the wings were found at angles of incidence in excess of three degrees. The experiments included balance tests, measurements of surface static pressure along seven generators and at two chord stations, the determination of contours of constant total pressure in the vortex region and some flow visualization with tufts, smoke, oil and a paraffin and chalk mixture. Author

N67-31974# Aeronautical Research Council (Gt. Brit.).
FURTHER EXPERIMENTS WITH 20 DEG. DELTA WINGS. PART III
P. T. Fink *In its* Some Early Expt. on Vortex Separation 1967 p 39–47 refs (See N67-31971 18-01)

Experiments supplementary to those previously reported are discussed. Spanwise distribution of loading ahead of a chord station and for conical flow for various values of incidence ratio are plotted. The positions of vortex core under different conditions are also described, along with measurements of circulation in a plane downstream of the wing. Preliminary work with yawed delta wings is mentioned. N.E.N.

N67-31989*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECTS OF JET PLUMING ON THE STATIC STABILITY OF FIVE ROCKET MODELS AT MACH NUMBERS OF 4, 5, AND 6 AND STATIC PRESSURE RATIOS UP TO 28 000
William F. Hinson and Robert J. McGhee Washington, NASA, Aug. 1967 69 p refs
(NASA-TN-D-4064) CFSTI: HC $3.00/MF $0.65 CSCL 01A

The effect of jet pluming on the normal force and pitching moment of five cone-cylinder–flare-finned models has been measured at free-stream Mach numbers of 4, 5, and 6. The Reynolds number per foot was 0.54 to 0.76×10^6 (1.77 to 2.49×10^6 per meter) at free-stream Mach numbers of 4 and 6. The range of jet-static-pressure ratios varied from a jet-off condition to values of 4000 to 8000 at free-stream Mach numbers of 4 and 6, respectively, for a rocket nozzle of exit Mach number of 2.24. With a sonic nozzle, the jet-static-pressure ratio was from 16,000 to 26,000 at free-stream Mach numbers of 4 and 6. Increasing the jet pressure ratio resulted in large jet plumes and initial turning angles approaching 100°, which in turn caused boundary-layer separation over large regions. Normal-force coefficients decreased to approximately a constant value with increasing jet pressure ratio associated with essentially complete flow separation over the body; however, when a flare afterbody was employed a larger jet pressure ratio was required before a near constant value was reached. All models generally displayed irregular pitching-moment-coefficient variations with jet pressure ratio, angle of attack, and Mach number. At moderate angles of attack and high jet pressure

ratios, normal-force and pitching-moment coefficients obtained with nozzles having exit Mach numbers of 2.24 and 1.0 at pressure ratios simulating the same initial turning angle of 90.3° were in poor agreement. Author

N67-32002*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SPANWISE LOADINGS AND AERODYNAMIC CHARACTERISTICS FOR A SERIES OF TRAILING-EDGE CONTROLS ON A 40° SWEPTBACK WING AT MACH NUMBERS OF 1.61 AND 2.01
Emma Jean Landrum and K. R. Czarnecki Washington, NASA, Nov. 1962 70 p refs
(NASA-TM-X-752) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

Models were tested at angles of attack from 0° to 12° for control deflections from −30° to 30°. Reynolds number based on the mean aerodynamic chord was 3.6×10^6. The linear theory overestimates by a considerable amount both the spanwise loadings and the integrated coefficients. The trends indicated by the theory are followed by the experimental spanwise loadings. For the controls having one end at the wing root, both theory and experiment indicate a decrease in loading inboard of the Mach line from the hinge-line apex. Author

N67-32015*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 10.03 OF LOW-ASPECT-RATIO WING-BODY CONFIGURATIONS SUITABLE FOR REENTRY
Lawrence E. Putnam and Cuyler W. Brooks, Jr. Washington, NASA, Dec. 1962 28 p refs
(NASA-TM-X-733) CSCL 01A (Declassified)

Tests were made on composite wing-body configurations in the Langley 15-inch hypersonic flow apparatus at angles of attack from about −4° to 42°. The models had circular, elliptical, 65°, and 75° triangular, and 65° and 75° clipped-tip triangular planform wings with cone-cylinder fuselages mounted on the upper surface of the wing. The Reynolds number, based on the wing mean aerodynamic chord, varied from 0.41×10^6 to 0.58×10^6. A description of the tunnel is included. Author

N67-32098*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART VI: DATA AND PERFORMANCE FOR STATOR 1 AND FLOW GENERATION ROTOR
21 Jul. 1967 101 p refs
(Contract NAS3-7603)
(NASA-CR-54549; PWA-FR-2286) CSCL 01A

An investigation of a slotted stator in a single-stage compressor was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor rotor and stator blade rows. The stator vanes were 65-series airfoils of constant camber and blade chord angle. The unslotted design diffusion factor and the design inlet Mach number were 0.521 and 0.644, respectively, at a radial position 90% of span from the vane tips. Measured deviation angles and loss coefficients were higher than predicted. The measured diffusion factor at 90% of span from the stator rip was 0.46 at design incidence. Author

N67-32134*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HEAT-TRANSFER AND PRESSURE MEASUREMENTS ON A CONCAVE-NOSE CYLINDER FOR MACH NUMBER RANGE OF 2.49 TO 4.44
Robert R. Stallings, Jr. and Paige B. Burbank Washington, NASA, Oct. 1959 22 p refs
(NASA-TM-X-221) CSCL 01A (Declassified)

Two types of flow phenomena were associated with this investigation: a steady-flow condition and a non-predictable, sporadic, unsteady-flow condition similar to inlet buzzing. During steady-flow conditions the local pressures from the stagnation point to approximately 80 percent of the concave-nose surface length corresponded to the total pressure behind a normal shock throughout the Mach number and angle-of-attack ranges. The stagnation heat-transfer coefficients on the concave nose were 20 percent of those for a hemisphere for steady-flow conditions and increased by a factor of 6 for unsteady-flow conditions. During steady-flow conditions the total convective heat input for a constant temperature potential was approximately the same for the concave nose and a flat-face nose—70 percent of the value for a convex hemispherical nose. Author

N67-32135*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AND LATERAL STABILITY CONTROL CHARACTERISTICS OF A RIGHT TRIANGULAR PYRAMIDAL LIFTING REENTRY CONFIGURATION AT MACH NUMBERS FROM 2.36 TO 4.65
Nickolai Charczenko and C. Donald Babb Washington, NASA, Sep. 1963 52 p refs
(NASA-TM-X-831) CSCL 01A (Declassified)

The investigation was conducted in the Langley Unitary Plan wind tunnel on a configuration with a 45° dihedral angle on the lower surfaces and a sweepback angle of 79.5°. Modifications to the basic configuration included a boattail extension to the body and the addition of speed brakes. Tests were conducted over an angle-of-attack range from about 2° to 30° and an angle-of-sideslip range from about −5° to 10°. The Reynolds number for the tests varied from 0.88×10^6 to 2.07×10^6, depending on Mach number. Author

N67-32139*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS AND ANGLES OF ATTACK UP TO 99° OF A REENTRY GLIDER HAVING FOLDING WING-TIP PANELS
Walter B. Olstad Washington, NASA, Oct. 1961 31 p refs
(NASA-TM-X-610) CSCL 01A (Declassified)

The configuration investigated consisted of a clipped delta wing with leading edges swept back 76° and an upper-surface-mounted fuselage. Folding wing panels were located near the rear of the vehicle. Tests were conducted at Mach numbers from 0.60 to 1.20 and angles of attack from −4° to 99°. Reynolds number based on the mean geometric chord of the fixed planform varied from 2.35×10^6 to 2.99×10^6. Author

N67-32145*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF WING PIVOT LOCATION ON LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A VARIABLE-SWEEP WING HAVING AN M PLANFORM
William P. Henderson and Edward J. Ray Washington, NASA, Oct. 1964 39 p refs
(NASA-TM-X-1022) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

An investigation was made in the high speed 7- by 10-foot tunnel to determine the effect of wing pivot location on the longitudinal aerodynamic characteristics of a variable-sweep wing having an M planform. The investigation was made with and without horizontal tails and with and without engine packs. The effects of wing leading-edge chord extension are are also included. Investigations were made at a Mach number of 0.40, at angles of attack from −2° to 22°, and for a Reynolds number per foot of 2.52×10^6. Author

N67-32160# Aix-Marseilles Univ. (France). Institut de Mecanique des Fluides.
COMPARATIVE STUDY AT M=7 OF THE SHOCK LAYER AND OF VISCOUS AND NON-VISCOUS SLIPSTREAMS OF BLUNT AND SHARP CONES [ETUDE COMPARATIVE A M=7 DE LA COUCHE DE CHOC ET DES SILLAGES NON VISQUEUX ET VISQUEUX DE CONES A POINTE VIVE OU EMOUSSEE]
31 Dec. 1966 64 p refs In FRENCH

Experimental determinations were made of the pressure and flux of heat convected by the surfaces of sharp and blunt cones at incidence angles between 0 and 20° at Mach number 7. Flow between shock layer and body is discussed with respect to both types of cones under viscous and nonviscous conditions, and experimental results are compared with accepted theory. In general, the uniform characteristics predicted by Newtonian theory were not evidenced. Transl. by M.W.R.

N67-32155*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FULL-SCALE WIND TUNNEL INVESTIGATION OF THE LOW SPEED STATIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A REENTRY CAPSULE
William I. Scallion Washington, NASA, Oct. 1959 10 p
(NASA-TM-X-220) CFSTI: HC $3.00/MF $0.65 (Declassified)

An experimental investigation has been made in a full-scale tunnel to determine the low speed static aerodynamic characteristics of a full-scale model of a reentry capsule. Static data are presented for the space capsule with a 40-inch and a 70-inch canister for an angle-of-attack range from −5° to 88.7°. Also included are the effects of a corrugated canister surface on the static stability characteristics. The test Mach number was 0.10 and the Reynolds number was 4.85×10^6 based on the maximum body diameter. Author

N67-32156*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF SOME EFFECTS OF FLEXIBILITY ON THE LIFT AND PITCHING-MOMENT CHARACTERISTICS OF A SERIES OF LOW-ASPECT-RATIO WING-BODY COMBINATIONS AT TRANSONIC SPEEDS
Robert V. Doggett, Jr. and A. Gerald Rainey Washington, NASA, Oct. 1960 50 p refs
(NASA-TM-X-343) CSCL 01A (Declassified)

Measurements of lift and pitching moment were made on a series of low aspect ratio wing-body combinations of different stiffnesses in the Mach number range from 0.70 to 1.10 and at angles of attack up to 30°. The configurations tested consisted of three different delta wings in combination with a single conical-cylindrical body. The three delta wings differed in leading edge-sweep angle, aspect ratio, and area. Both rigid and flexible models were tested at Reynolds numbers per foot of 3.2×10^6 and 1.8×10^6. The experimental results indicated that there is no appreciable effect of vehicle flexibility on the lift characteristics for the models tested. The pitching moment characteristics were affected by flexibility; in general, increasing flexibility produced an appreciable deterioration of the static longitudinal stability characteristics. Author

N67-32265*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT TEST OF A 31.2-FOOT-DIAMETER MODIFIED RINGSAIL PARACHUTE DEPLOYED AT A MACH NUMBER OF 1.39 AND A DYNAMIC PRESSURE OF 11.0 POUNDS PER SQUARE FOOT
John S. Preisser, Clinton V. Eckstrom, and Harold N. Murrow Washington, NASA, Aug. 1967 46 p refs Film Supplement Number L-988 to this Report is Available on Loan from Langley Res. Center
(NASA-TM-X-1414) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A 31.2-foot (9.51 meter) nominal diameter (reference area 764 ft^2 (71.0 m^2)) ringsail parachute modified to provide 15-percent geometric porosity was flight tested while attached to a 201-pound mass (91.2 kilogram) instrumented payload as part of the rocket launch portion of the NASA Planetary Entry Parachute Program (PEPP). The parachute deployment was initiated by the firing of a mortar at a Mach number of 1.39 and a dynamic pressure of 11.0 lb/ft^2 (527 N/m^2) at an altitude of 122,500 feet (37.3 kilometers). The parachute deployed to suspension-line stretch (snatch force) in 0.35 second, and 0.12 second later the drag force increase associated with parachute inflation began. The parachute inflated in 0.24 second to the full-open condition for a total elapsed opening time of 0.71 second. The maximum opening load of 3970 pounds (17,700 newtons) came at the time the parachute was just fully opened. During the deceleration period, the parachute exhibited an average drag coefficient of 0.52 and oscillations of the parachute canopy were less than 5°. During the steady-state terminal descent portion of the test period, the average effective drag coefficient (based on vertical descent velocity) was 0.52. Author

N67-32272*# Boeing Co., Renton, Wash. Airplane Div.
A METHOD OF OPTIMIZING CAMBER SURFACES FOR WING–BODY COMBINATIONS AT SUPERSONIC SPEEDS. PART II: DIGITAL COMPUTER PROGRAM DESCRIPTION
J. E. Brown Oct. 1965 742 p refs
(Contract NAS2-2282)
(NASA-CR-69175; D6-10741, Pt. II, Vol. 2) CSCL 01C

This document describes a digital computer program developed to solve the problem of optimizing the wing camber surfaces for wing–body combinations at supersonic speeds. In addition, the program will solve the direct problem of calculating the pressures, forces, and moments on a given configuration, and the indirect problem of determining the wing shape for a given lift distribution. A wing alone, body alone, or wing–body combination may be defined. Basically, the geometry sections redefine the body as an equivalent body of circular cross section. The wing, and that part of the body in the region aft of the wing leading-edge intersection, are subdivided into a large number of panels. The wing may be defined to have thickness or may consist of a camber surface only. The problem is solved by first computing the velocity components induced by the various singularities that represent the configuration. The body thickness and camber effects are represented by line sources and doublets along the body axis, and wing thickness effects by a distribution of sources located in the wing reference plane. The effects of camber and incidence of the wing, together with any residual interference effects, are simulated by a surface distribution of vortices on the wing and body. Once the velocity components have been computed, the program determines the strengths of the singularities required to satisfy the given boundary conditions. The program selects the boundary conditions appropriate to the particular direct, indirect, or optimization problem being considered, and solves the problem. Author

N67-32309*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MEASUREMENTS OF FLOW PROPERTIES IN THE VICINITY OF THREE WING–FUSELAGE COMBINATIONS AT MACH NUMBERS OF 1.81 AND 2.01
Harry W. Carlson Washington, NASA, Oct. 1959 74 p refs
(NASA-TM-X-64) CFSTI: HC $3.00/MF $0.65 CSCL 01A (Declassified)

This investigation has been conducted in order to study in detail the actual flow below the wing of wing–body combinations by the use of wind tunnel flow surveys. For a number of sample cases, the linearized theory has been used to calculate the flow properties and is compared with experimental results in an effort to demonstrate the range of applicability of the theory. The tests were made in a 4- by 4-foot supersonic pressure tunnel at Mach

numbers of 1.61 and 2.01 for three wing–body combinations employing a swept wing, a trapezoidal wing, and a delta wing. Reynolds numbers for the tests corresponding to the Mach numbers were 2.8×10^6 and 2.3×10^6 per foot. Local Mach number, pressure coefficient, downwash, and sidewash were measured at angles of attack of 0°, 4°, and 8°. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-31534*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

TABULATED DATA FROM A PRESSURE-DISTRIBUTION INVESTIGATION AT MACH NUMBER 2.01 OF THE WING OF A CANARD AIRPLANE MODEL

Cornelius Driver and James L. Jacocks. Washington, NASA, Dec. 1959. 201 p.

(NASA-TM-X-140) CFSTI: HC $3.00/MF $0.65 CSCL 01C (Declassified)

Tests to determine the pressure distribution on the trapezoidal wing of a generalized canard airplane configuration have been made in a supersonic pressure tunnel. Configurations were investigated to determine the effects of three forebody lengths; high, mid, and low wing positions; and canard deflections of 0°, 5°, and 15° through an angle-of-attack range from 0° to 15°. Limited tests were made of the effects of canard plan form and area. Tests were made at an angle of attack of 5° through the sideslip range from −15° to 15° of a swept vertical tail mounted both on the fuselage center line and on the wing at the 50-percent-semispan station. The tabulated pressure coefficients are presented without analysis. Author

N67-31606*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

PROCEEDINGS OF NASA CONFERENCE ON SUPERSONIC-TRANSPORT FEASIBILITY STUDIES AND SUPPORTING RESEARCH

Washington, NASA, Dec. 1963. 543 p. refs. Conf. held at NASA, Langley Research Center, 17–19 Sep. 1963.

(NASA-TM-X-905) CFSTI: HC $3.00/MF $0.65 CSCL 01C (Declassified)

Contractual feasibility studies of four conceptual supersonic transport designs are presented, together with summaries of NASA in-house research pertinent to the supersonic transport. For individual titles, see N67-31607 through N67-31635.

N67-31607*# National Aeronautics and Space Administration, Washington, D. C.

THE SUPERSONIC-TRANSPORT PROGRAM

Charles H. Zimmerman *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p vii–viii (See N67-31606 18-02)

Introductory remarks are presented that were given at the opening of a conference on research activities, carried out by NASA, on the development of a supersonic commercial transport. P.V.E.

N67-31608*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

OBJECTIVES AND GUIDELINES OF THE NASA SUPERSONIC-TRANSPORT FEASIBILITY STUDIES

Laurence K. Loftin, Jr. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 1–3 (See N67-31606 18-02)

The objectives and guidelines of the feasibility studies presented in the first part of the conference are discussed. The objectives of the studies were: (1) to evaluate and compare promising design concepts relative to all facets of a successful commercial design; (2) to clarify the present state-of-the-art for guidance of the national program; and (3) to define the requirements for future NASA research. P.V.E.

N67-31609*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

SUMMARY OF INITIAL NASA SCAT AIRFRAME AND PROPULSION CONCEPTS

Donald D. Baals *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 5–20 (See N67-31606 18-02)

Four basic configuration concepts were submitted to two airframe contractors for feasibility studies. The basic concepts are described, and the supporting aerodynamic data are reviewed. In order to provide a basis for evaluation of the configuration concepts, estimated engine performance characteristics were provided to the feasibility-study contractors. These general engine characteristics are reviewed herein. Author

N67-31610*# Lockheed-California Co., Burbank.

SUMMARY OF LOCKHEED SCAT FEASIBILITY STUDIES

R. Richard Heppe and Jim Hong *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 21–92 (See N67-31606 18-02)

Details are presented on the analysis of engine possibilities, configuration development, and stability and control considerations for SCAT 4, 15, 16, and 17 concepts. Engine studies indicated that the advanced technology, duct-burning-turbofan type engine was the best choice, with the advanced dry turbojet a close competitor on the basic mission. The variable-sweep SCAT 16 configuration and the low-aspect ratio fixed delta wing SCAT 17 configuration were considered to be feasible designs. Other conclusions include: (1) Simplicity and weight considerations are as important as high aerodynamic efficiency. (2) The transport speed must be substantially greater than Mach 2.2 for intercontinental range unless advanced engines are used. Extensive graphed and tabulated data are included. N.E.N.

N67-31611*# Boeing Co., Seattle, Wash. Airplane Div.

SUMMARY OF BOEING SCAT FEASIBILITY STUDIES

Lloyd T. Goodmanson, William T. Hamilton, and Maynard L. Pennell *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 93–137 refs (See N67-31606 18-02)

The airplane configurations that have been developed to meet specific design objectives are described, and comparative performance is presented. The technical aspects of the study in the areas of structural design, propulsion, and aerodynamics are briefly reviewed. The major conclusions are as follows: The SCAT 16 and SCAT 17 concepts are feasible approaches to the design of a supersonic transport. The concept of variable-sweep wings, exemplified by SCAT 16, offers significant improvements in operational flexibility as compared with the conventional fixed-wing concept of SCAT 17. SCAT 4 and SCAT 15 exhibit superior aerodynamic efficiency. Titanium structure and advanced engine technology must be employed in the supersonic transport in order to

achieve reasonable economic performance. An aluminum airframe, designed to cruise at Mach numbers near 2.0 and according to the SCAT guidelines, has a gross weight too large to be economically feasible. In addition, it could not meet the sonic-boom overpressure limitations. Author

N67-31612*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA SUMMARY AND ASSESSMENT OF FEASIBILITY STUDY RESULTS

John G. Lowry *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 139–152 (See N67-31606 18-02)

The studies have indicated that through the use of an advanced engine technology and the use of an advanced material, titanium, either the variable-sweep approach or the fixed-wing approach can meet the required supersonic commercial air transport (SCAT) design objectives. Based on the same design objectives, an aluminum Mach 2.2 airplane did not have the same range, payload, or sonic-boom capability, even with prohibitive increase in gross weight. Author

N67-31617*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

CONFIGURATION EFFECTS OF THE CHARACTERISTICS OF DELTA-WING SUPERSONIC TRANSPORTS

Adrian E. Anderson *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 203–221 refs (See N67-31606 18-02)

The topics discussed include: a comparison between the stability characteristics of the basic SCAT 17 configuration and configurations similar to the SCAT 17 designs proposed by the two feasibility study contractors; the lateral stability problem which arises when a design is compromised to achieve higher efficiency and directional stability; possible configuration and control utilization changes which can be made to improve efficiency; the effect of airfoil section and flap deflection on transonic efficiency; low-speed high-lift studies; and finally, aileron and spoiler characteristics obtained at high Mach numbers. Author

N67-31618*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STABILITY AND HIGH-LIFT STUDIES APPLICABLE TO VARIABLE-SWEEP SUPERSONIC-TRANSPORT CONFIGURATIONS

William J. Alford, Jr., Vernard E. Lockwood, Linwood W. Mc Kinney, and Richard K. Greif (NASA. Ames Res. Center) *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 223–255 refs (See N67-31606 18-02)

A consideration of the characteristics indicates that the more outboard pivot locations can be used to reduce the aerodynamic-center variation with wing sweep angle, and this reduction results in higher supersonic trimmed lift–drag ratios. Of the several configuration concepts considered, the smallest maximum lift–drag-ratio variation with stability level or center-of-gravity location was obtained with the auxiliary wing concept. The outboard pivot wings with fixed forward area have pitch instability problems at high lifts, but these problems can be minimized by use of suitable forewing configurations and wing devices. The large spans provided by variable sweep allows the efficient attainment of high lift coefficients that provide very good take-off and landing characteristics. Author

N67-31619*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA WING PLANFORM STUDIES

Robert T. Taylor, William P. Henderson, Raymond M. Hicks, and Edward J. Hopkins (NASA. Ames Res. Center) *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 257–266 (See N67-31606 18-02)

Supersonic commercial air transport (SCAT) studies have shown the need for increased performance for wings with supersonic leading edges and the requirements for low-speed stability research on planforms with subsonic edges. Summarized are recent planform studies that indicate wing warp to have a powerful effect on supersonic trimmed lift–drag ratio. Studies at low speed have shown that notched planforms tend to reduce the pitchup tendency. Author

N67-31620*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LATERAL-DIRECTIONAL STABILITY STUDIES AT SUPERSONIC SPEEDS

M. Leroy Spearman *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 267–275 (See N67-31606 18-02)

A substantial quantity of research information was obtained on the stability characteristics of aircraft configurations at supersonic speeds. The investigations include the effects of variable wing sweep, wing modifications, vertical tail modifications, and body cross section changes. Illustrative examples of the results are presented in order to point out some of the factors that affect the lateral-directional stability characteristics. Author

N67-31621*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

ADDITIONAL CONFIGURATION APPROACHES

A. Warner Robins and Richard T. Whitcomb *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 277–290 (See N67-31606 18-02)

Some of the major problems encountered in the SCAT feasibility studies are reviewed and changes to improve the four basic SCAT configurations are discussed. Improvements in nearly all problem areas appear possible. Advanced versions of each of the four SCAT concepts are being investigated. Author

N67-31628*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

CONFIGURATION EFFECTS OF SONIC BOOM

Harry W. Carlson *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 381–398 refs (See N67-31606 18-02)

An outline of current theoretical methods for sonic boom estimation is presented, and the correlation of this theory with experimental data is illustrated. Sonic boom lower bound concepts are used in examining the dependence of sonic boom on configuration variables and in pointing out design considerations tending to minimize the problem. Author

N67-31629*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

FACTORS AFFECTING COMMUNITY ACCEPTANCE OF THE SONIC BOOM

Harvey H. Hubbard and Domenic J. Maglieri *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 399–412 refs (See N67-31606 18-02)

Discussions are given of ground overpressure exposures for current military operations and how these exposures are affected by the atmosphere and by aircraft maneuvers. Brief remarks are included about various operations for which some response information has been obtained. Indications are that building response is a very important factor in influencing public reaction. Based on these data, some estimates are given regarding the frequency and nature of damage incidents resulting from sonic boom exposure. Author

N67-31630*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ENGINE AND BOUNDARY-LAYER NOISE CONSIDERATIONS
Jimmy M. Cawthorn and Domenic J. Maglieri *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 413–423 refs (See N67-31606 18-02)

The main findings of the contractor studies are summarized with regard to noise problems during the take off, initial climb, and landing approach. Data are presented in the form of perceived noise levels, and comparisons are made with a current subsonic transport of comparable range. Airport noise levels are estimated to be higher than those for the current aircraft, whereas the climbout and landing-approach noise levels can be of the same order of magnitude or lower, depending on the aircraft configuration and the operating procedures used. Brief mention is also made of the noise-induced structural-response problem during take off and cruise. Author

N67-31632*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
CONSIDERATION OF SOME AIRWORTHINESS REQUIREMENTS FOR SUPERSONIC TRANSPORTS
Thomas L. Coleman *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 439–456 refs (See N67-31606 18-02)

Airworthiness requirements in the areas of structural design criteria, performance, and handling qualities are discussed. Several areas are indicated wherein present Civil Air Regulations are not directly applicable to the supersonic transport. For some areas, it appears that the requirements can be adapted to supersonic transport configurations by only minor modifications or extensions. For other areas, it appears that basic concepts on which the requirements are based will require reexamination. Author

N67-31633*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF SATISFACTORY HANDLING QUALITIES FOR A SUPERSONIC-TRANSPORT CONFIGURATION THROUGH SIMULATOR STUDIES
Maurice D. White, Alan E. Faye, Jr., and George E. Cooper *In* NASA. Langley Res. Center Proc. of NASA Conf. of Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 457–469 refs (See N67-31606 18-02)

It appears that simulation studies of an early supersonic transport design that coping with the problems of longitudinal aerodynamic-center shift with Mach number can present difficulties other than the well known trim-drag effects. The sensitivity of the directional stability to longitudinal center-of-gravity position is one of a number of factors that result in relatively novel lateral-directional handling-quality problems which may require careful tailoring of the design. In cruising flight, augmentation of aerodynamic damping appears to be a requirement for both the variable-sweep and the delta-wing–canard configurations. Author

N67-31634*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SIMULATOR STUDY OF THE LATERAL DIRECTIONAL HANDLING QUALITIES OF TWO SCAT CONFIGURATIONS IN THE LANDING APPROACH
Walter E. McNeill and Robert C. Innis *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 471–484 refs (See N67-31606 18-02)

A piloted simulator study of the lateral directional handling qualities of one SCAT 16 and two SCAT 17 configurations showed that the SCAT 16 and one SCAT 17 would have acceptable handling qualities in an emergency condition without stability augmentation. The SCAT 16 exhibited almost satisfactory behavior without augmentation. It was found that these SCAT 16 and 17 configurations could be improved to a satisfactory level, as far as lateral directional stability is concerned, by ordinary means of stability augmentation. Author

N67-31671# Federal Aviation Agency, Atlantic City, N. J. National Aviation Facilities Experimental Center.
COLLISION AVOIDANCE: A BIBLIOGRAPHY, 1955–APRIL 1967
Dorothy E. Bulford, comp. May 1967 71 p refs
(AD-652608) CFSTI: HC $3.00/MF $0.65

Safety in the air has always been the paramount goal of the FAA, and the subject of collision avoidance one of primary interest. The Bibliography was compiled with the hope that researchers in the FAA, and among its contractors will find it valuable in their continued search for a system that will meet the needs of the aviation industry. TAB

N67-31720# Federal Aviation Agency, Washington, D. C.
EMERGENCY EVACUATION TESTS OF A CRASHED L-1649
J. D. Garner and John G. Blethrow Aug. 1966 45 p
(AM-66-42) CFSTI: HC $3.00/MF $0.65

Four basic evacuation tests were performed on a crashed L-1649 to document problem areas, passenger reaction, emergency lighting slope of flooring, and other items affecting passenger egress. Two day and two night tests were run, with different crews and passengers for each. The tests were designed to observe the reactions of the crews and passengers under different emergency conditions. Data were collected by tape recordings, motion picture film, and questionnaires. Author

N67-31729*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A COMPARISON OF FLIGHT-MEASURED CARRIER-APPROACH SPEEDS WITH VALUES PREDICTED BY SEVERAL DIFFERENT CRITERIA FOR 41 FIGHTER-TYPE AIRPLANE CONFIGURATIONS
Maurice D. White, Bernard A. Schlaff, and Fred J. Drinkwater, III Washington, NACA, 8 May 1958 128 p refs
(NACA-RM-A57L11) CSCL 01C (Declassified)

Forty-one jet-propelled fighter-type airplane arrangements, including various wing boundary-layer-control arrangements, have been tested in flight in the landing-approach configuration. Lift and drag characteristics are presented for these airplanes. The minimum comfortable approach speeds for carrier-type landings, evaluated by four test pilots, are compared with approach speeds that would be predicted by a number of simple criteria. Author

N67-31732*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC HORIZONTAL-ATTITUDE VTOL AIRPLANE MODEL AT MACH NUMBERS OF 1.57, 2.14, 2.54, AND 2.87
Arthur E. Franklin and Robert M. Lust Washington, NASA, Oct. 1960 155 p
(NASA-TM-X-213) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

An investigation of the drag and static longitudinal and lateral stability characteristics of a model of a supersonic horizontal-attitude VTOL airplane has been conducted in a wind tunnel. The model has a wing with a 9.3° sweepback of the quarter-chord line, aspect ratio of 2.42, a taper ratio of 0.43, dihedral of 0°, and a modified airfoil section. The model included a vertical tail and ventral fin and a horizontal tail, one with 0° dihedral and another with −30° dihedral. The model also had wing-tip nacelles. The results are presented without analysis. Author

N67-31824*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE SURFACE COOLANT REQUIREMENTS OF HYPERSONIC GLIDERS
John V. Becker and Peter F. Korycinski Washington, NASA, Apr. 1959 91 p refs
(NASA-MEMO-1-29-59L) CSCL 01C (Declassified)

A general assessment was made of the coolant heat capacity requirements of hypersonic gliders in which the wing skin and leading edge are the principal elements requiring cooling to maintain the surface temperature within desired limits. For any design temperature and range, the coolant requirement can be minimized by operation at a high lift coefficient and low lift-drag ratio. For global range or satellite reentry designs in which high lift-drag ratio is not required, complete elimination of the surface coolant requirement appears possible for all-metal superalloy structures with a nominal design temperature of 2,000°F. Author

N67-31933*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF A TAILLESS FIXED-WING SUPERSONIC TRANSPORT CONFIGURATION AT MACH NUMBER 2.20
Gerald V. Frost and William A. Corlett Washington, NASA, May 1964 45 p
(NASA-TM-X-960) CFSTI: HC $3.00/MF $0.65 CSCL 01C (Declassified)

An investigation has been conducted in a 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.20 to determine the longitudinal and lateral aerodynamic characteristics of a model of a tailless fixed-wing supersonic transport configuration. The model was investigated with three different wing planforms, a trapezoid, a delta, and a modified delta having an ogee-shaped leading edge, with and without camber and twist. The results indicate that the model was longitudinally stable about the selected center-of-gravity locations with each of the test wings. The cambered and twisted trapezoid-wing configuration had the highest maximum untrimmed lift-drag ratio (6.45). Trim control by means of the elevons was relatively low and significantly lowered the maximum lift-drag ratio of the flat-wing (zero camber) configurations. The trim penalty was diminished by the positive pitching moment provided by camber and twist. The flat-wing configurations and the cambered and twisted delta- and trapezoid-wing configurations had about the same directional stability and were stable to an angle of attack of about 12°. Author

N67-31956# Wissenschaftliche Gesellschaft für Luft- und Raumfahrt, Cologne (West Germany).
REPORT ON THE SESSION OF THE WGLR SUBCOMMITTEE ON FLIGHT CONTROL [BERICHT UEBER DIE SITZUNG DES WGLR-FACHAUSSCHUSSES FLUGFUEHRUNG]
Oct. 1966 96 p refs In GERMAN and ENGLISH Conf. held in Stuttgart, 14 Dec. 1965
(DLR-MITT-66-19) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. STEERING PROBLEMS AND NECESSITY OF AUTO-STABILITY IN SUPERSONIC COMMERCIAL AIRCRAFT WITH SLENDER WINGS R. Brockhaus et al (Deutsche Forschungsanstalt für Luft- und Raumfahrt) p 7–38 refs (See N67-31957 18-02)

2. SOME PROBLEMS IN THE AUTOMATIC CONTROL AND STABILITY OF SUPERSONIC TRANSPORT AIRCRAFT R. Ruggles et al (Elliott Bros., Ltd.) p 37–59 refs (See N67-31958 18-02)

3. SAFETY PROBLEMS IN THE CONSTRUCTION OF ELECTROHYDRAULIC SERVOSYSTEMS IN THE STEERING SYSTEM M. Roger Copee et al (Sud Aviation) p 61–96 (See N67-31959 18-03)

N67-31957# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany).
STEERING PROBLEMS AND NECESSITY OF AUTO STABILITY IN SUPERSONIC COMMERCIAL AIRCRAFT WITH SLENDER WINGS [STEUERPROBLEME UND NOTWENDIGKEIT VON AUTOSTABILISIERUNG BEI UEBERSCHALLVERKEHRSFLUGZEUGEN MIT STARKER PFEILUNG]
R. Brockhaus et al *In* WGLR Rept. on the Session of the WGLR Subcomm. on Flight Control Oct. 1966 p 7–36 refs (See N67-31956 18-02)

The construction of supersonic transporters with sweptback wings creates special aerodynamic problems and requires a steering system to compensate for: (1) increased sensitivity against gust and side winds; (2) adverse yaw and pitch inertia control with possible automatic flare and start directions; and (3) high incidence and low roll damping effects of the low lift curve slope. A comprehensive autopilot system is required for fully automatic landing procedures. Transl. by G.G.

N67-31958# Elliott Bros., Ltd., London (England). Military Aircraft Controls Div.
SOME PROBLEMS IN THE AUTOMATIC CONTROL AND STABILITY OF SUPERSONIC TRANSPORT AIRCRAFT
R. Ruggles et al *In* WGLR Rept. on the Session of the WGLR Subcomm. on Flight Control Oct. 1966 p 37–59 refs (See N67-31956 18-02)

Evaluated are a pitch autostabilizer, a lateral-directional autostabilizer, an autoflare, and an electrical signalling system for automatic control and aerodynamic flight stability of supersonic transport aircraft. Calculations show that the application of a normal acceleration command autopilot to the autoflare maneuver is advantageous; its performance is not very dependent on ground effect or aircraft position and the effects of wind shear, discrete gusts, and random turbulence are contained within reasonable limits. G.G.

N67-31965*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
HYDRODYNAMIC CHARACTERISTICS OF A MODEL OF A PROPOSED SIX-ENGINE HULL-TYPE SEAPLANE DESIGNED FOR SUPERSONIC FLIGHT
Claude W. Coffee, Jr. Washington, NACA, 14 Jul. 1958 32 p refs
(NACA-RM-L58E13) CSCL 01C (Declassified)

The configuration used in this investigation had four engines mounted on top of the wing in individual nacelles and two engines mounted on top of the aft section of the hull with their inlets located on top of the wing. Smooth-water resistance, spray characteristics, and take-off and landing stability were determined. A brief investigation was made of the rough-water spray characteristics. Author

N67-32017*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS AT A MACH NUMBER OF 2.20 OF A VARIABLE-WING-SWEEP STOL CONFIGURATION
Gerald V. Foster and Odell A. Morris Washington, NASA, Oct. 1960 24 p refs
(NASA-TM-X-329) CSCL 01C (Declassified)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.20 to determine the aerodynamic characteristics of a variable-wing-sweep STOL configuration with outboard panels swept back 50°, 75°, and 80°. Tests were made through an angle-of-attack and angle-of-sideslip range for the complete configuration. Also some tests were made with various horizontal-tail settings and for various combinations of component parts. Author

N67-32095# Research Analysis Corp., McLean, Va. Science and Engineering Dept.
COST ANALYSIS OF SUPERSONIC TRANSPORT IN AIRLINE OPERATION, VOLUME I
Robert A. Booth, Ansel V. Gould, Samuel A. La Mar, James L. Johnston, and James C. Willyard 31 Dec. 1966 167 p refs
(Contract FA-SS-66-12)
(RAC-R-20, Vol. I; AD-652311) CFSTI: HC $3.00/MF $0.65

Two approaches were used in the development of an operating cost model. First, a regression model, based on airline experience data, was developed. Second, qualitative and quantitative testing of existing cost-estimating relations was performed to determine internal consistency and computed variance with CAB data. The model selected was based on the second approach. Further modifications then were made to the selected model to reflect the airline experience of 1964 and 1965 and the information and opinions obtained during discussions with personnel from both airlines and manufacturers of aircraft. The operating cost model consists of two machine programs. The first program, Mission-Supersonic Transport (MISST), is used to determine the block fuel and block time for a specified payload and block distance. MISST is intended primarily as a tool for analyzing missions having a mixture of subsonic and supersonic cruise segments, also to compare standard and hot-day performances and the effect of varying gross takeoff weights. The second program, Operating Cost Model (OCMODL), is used to compare the output of the various methods of computing direct and indirect operating costs developed by different organizations and to compare the operating costs of different aircraft, both subsonic and supersonic. OCMODL accepts input from the MISST program or any other source and provides costs expressed in dollars per mile, dollars per trip, and dollars per seat mile for all direct and indirect cost accounts. TAB

N67-32128# Institute for Defense Analyses, Arlington, Va. Economic and Political Studies Div.
DEMAND ANALYSIS FOR AIR TRAVEL BY SUPERSONIC TRANSPORT. VOLUME II: APPENDIXES
Norman J. Asher, William F. Beazer, William A. Cox, Richard F. Muth, and Walter Y. Oi Dec. 1966 215 p refs
(Contract FA-SS-66-14)
(R-118, Vol. 2; IDA/HQ-66-5652, Vol. 2; AD-652310) CFSTI: HC $3.00/MF $0.65

The Report projects to 1990 the potential demand for a US SST in competition with the British-French Concorde, and examines the effects on the US balance of payments of these projections and the resulting international fleet mixes. The analysis is in three parts: (1) Passenger demand is projected by first estimating the total demand for air travel in terms of revenue passenger miles and then the extent of passenger preference for supersonic over subsonic travel. (2) Passenger demand is converted into aircraft demand and fleet mixes under various assumptions as to boom restriction, passenger valuation of travel time, and fares; and international fleet mixes are determined. (3) The US balance-of-payments implications of these aircraft and travel demands are then projected. Results are, in general, presented for a variety of conditions intended to bracket the range of possibilities. These results are given on two volumes. The present volume (Volume II) contains the appendixes to the main volume (Volume I, AD-652 309). TAB

N67-32140*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SPEED CHARACTERISTICS OF A VARIABLE-SWEEP SUPERSONIC TRANSPORT MODEL WITH A BLENDED ENGINE FUSELAGE AND ENGINE-MOUNTED TAILS
Vernard E. Lockwood and Wilson E. Thompson Washington, NASA, Nov. 1964 81 p refs
(NASA-TM-X-1038) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

Longitudinal and lateral stability and pitch control characteristics were determined for a model of a supersonic transport airplane configuration designated SCAT 14. The geometric variables studied were wing sweep, wing twist, and variations in sweep and deflection of the fixed area of the model between the fuselage and the movable wing. Lateral stability data are included for one model configuration through a range of leading-edge sweep angles from 13.5° to 75°. The investigation was made in the Langley 300-MPH 7- by 10-foot tunnel at a Mach number of 0.18 which corresponds to a Reynolds number per foot of 1.24×10^6. Author

N67-32141*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
LARGE-SCALE LOW-SPEED WIND-TUNNEL TESTS OF A DELTA WINGED SUPERSONIC TRANSPORT MODEL TO DETERMINE AERODYNAMIC EFFECTS OF FORWARD OR REVERSE THRUST
William H. Tolhurst and Kiyoshi Aoyagi Washington, NASA, Nov. 1964 35 p refs
(NASA-TM-X-1017) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

The longitudinal characteristics of the airplane with four wing-pod-mounted jet engines operating in either forward or reverse thrust are presented for various combinations of flap deflection, and horizontal-tail incidence and droop. A brief survey of horizontal-tail skin temperatures is also presented. The Reynolds number range of the test was from 17.2×10^6 to 32.2×10^6. Author

N67-32142*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LOW-SPEED EFFECTS OF HIGH-LIFT DEVICES ON THE AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC TRANSPORT MODEL WITH OUTBOARD TAILS
William C. Sleeman, Jr., Edward J. Ray, and Paul G. Fournier Washington, NASA, Oct. 1963 26 p refs
(NASA-TM-X-895) CSCL 01C
(Declassified)

An investigation was conducted in the high speed 7- by 10-foot tunnel to determine the effects of high-lift devices on the longitudinal stability and trim of an outboard-tail supersonic transport configuration at low speeds, and to determine the lift coefficient available for landing. The tests were conducted over an angle of attack range from approximately −1° to 25° at a test Reynolds number of approximately 2.69×10^6. Author

N67-32143*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF A TAILLESS FIXED-WING SUPERSONIC TRANSPORT MODEL AT MACH NUMBERS FROM 1.80 TO 2.86
William A. Corlett and Gerald V. Foster Washington, NASA, Aug. 1964 46 p
(NASA-TM-X-992) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

A wind tunnel investigation has been made to determine the longitudinal and lateral aerodynamic characteristics of a model of a tailless supersonic transport airplane having three different wing planforms: a modified delta having an ogee-shaped leading edge, a delta, and a trapezoid, both with and without camber and twist. Three different forebodies were investigated in order to determine the combined effects of modifying the forebody camber and fineness ratio. Author

N67-32144*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF A THREE-ENGINE SUPERSONIC TRANSPORT MODEL HAVING A LOW-ASPECT-RATIO VARIABLE-SWEEP WARPED WING

Odell A. Morris and Dennis E. Fuller Washington, NASA, Sep. 1964 61 p refs
(NASA-TM-X-1011) CFSTI: HC $3.00/MF $0.65 CSCL 01C
(Declassified)

An investigation was conducted in a wind tunnel to determine the longitudinal and lateral aerodynamic characteristics at Mach numbers of 2.40, 2.60, and 2.96 of a supersonic transport model (SCAT 16-B) which was designed for a Mach number of 2.6. Tests were made on the configuration with three different wing glove shapes (sweep angles) and for several horizontal-tail deflections with the wing in a fully swept position. Author

N67-32321*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FULL-SCALE WIND-TUNNEL INVESTIGATION OF A VTOL AIRCRAFT WITH A JET-EJECTOR SYSTEM FOR LIFT AUGMENTATION
Jerry V. Kirk and David H. Hickey Washington, NASA, Nov. 1966 51 p refs
(NASA-TN-D-3725) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Aerodynamic characteristics of a VTOL aircraft incorporating a jet ejector for augmenting lift have been examined from hover up to and including wing-supported flight. Ejector performance was measured statically and with forward speed. The maximum static augmentation ratio measured was 1.19. The ratio of ejector thrust with forward speed to static ejector thrust increased with forward speed. In general, the aircraft had nearly neutral longitudinal stability at angles of attack below wing stall, but above wing stall, pitch-up was severe. Lateral and directional stability were positive. Control power for trim in transition appeared to be adequate except for recovering from post stall pitch-up. Results from tests in a full-scale wind tunnel, in flight, and in a small-scale wind tunnel generally agree well. Author

N67-32394*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
THEORETICAL DYNAMIC ANALYSIS OF THE LANDING LOADS ON A VEHICLE WITH A TRICYCLE LANDING GEAR
Richard B. Noll and James M. McKay Washington, NASA, Aug. 1967 33 p refs
(NASA-TN-D-4075) CFSTI: HC $3.00/MF $0.65 CSCL 01C

This theoretical analysis uses equations that are simplified in order to provide a more convenient yet adequate analysis for most vehicles. The adequacy of the simplified analysis for simulating the landing dynamics and loads of a vehicle is illustrated by comparing results of calculations with flight test data from the X-15 research airplane. The feasibility of using the modified analysis for investigating off-design landing contingencies is demonstrated by examples of studies performed for the X-15. Author

N67-32478*# Lockheed-California Co., Burbank.
STUDY ON THE FEASIBILITY OF V/STOL CONCEPTS FOR SHORT HAUL TRANSPORT AIRCRAFT
Mar. 1967 76 p refs Addendum Rept.
(Contract NAS2-3035)
(NASA-CR-73111; LR-20573) CFSTI: HC $3.00/MF $0.65 CSCL 01B

Weight standardization, tilt rotor and stopped rotor optimization, and noise sensitivity analysis are reported in relation to the feasibility of V/STOL concepts for short-haul transport aircraft. The sensitivity analyses deal with noise from the propeller and rotor rotation, vortex, jet, turboshaft engine exhaust, and lift fan. Contributing noise sources are discussed for the following aircraft: (1) deflected slipstream, (2) jet flap, (3) fan-in-wing, (4) tilt rotor, and (5) stopped rotor prop. M.W.R.

N67-32498# Booz-Allen Applied Research, Inc., Bethesda, Md.
SUPERSONIC TRANSPORT DEVELOPMENT AND PRODUCTION COST ANALYSIS PROGRAM, VOLUME I Final Report
Dec. 1966 307 p refs
(Contract FA-SS-66-13)
(AD-652308) CFSTI: HC $3.00/MF $0.65

The report documents the results of a cost analysis directed to the determination of independent estimates for development and procurement costs of the proposed supersonic transport (SST). The analysis of these costs was undertaken in support of the SST competition and economic feasibility studies being conducted by the Federal Aviation Agency. Statistical regression techniques coupled with engineering/analog methods were employed to produce cost estimating relationships (CERs) for predicting SST costs. CERs were derived for predicting development and production costs of the airframe, engines, avionics, and aircraft servicing equipment of the proposed SST. The CERs have been exercised herein to compute the anticipated costs of procuring various quantities of SST aircraft. In addition, since the economic study is to examine the impact of competition with other aircraft, cost estimates were computed for the Boeing 707 and 747; the Douglas DC-8, DC-8-63, and DC-10; and the Anglo-French supersonic transport, Concorde. The study concludes with a comparison of SST costs as determined using the SAARINC/RMC relationships herein with those of the competing airframe and engine manufacturers. TAB

N67-32538# Technology, Inc., Dayton, Ohio.
CONTINUED STUDY OF RANDOM ALTITUDE DEVIATIONS OF GENERAL AVIATION AIRCRAFT DURING CRUISE Final Report
Larry E. Clay, Robert J. Marshall, and Joseph F. Braun, Jr. Jan. 1967 56 p refs
(Contract FA-65-WA-1163)
(RD-67-8; AD-652615) CFSTI: HC $3.00/MF $0.65

In a continued Flight Technical Error study of general aviation aircraft to investigate the random deviation of such airplanes from their intended cruise altitude, the cruise sections from more than 1000 hours of recorded data were stratified by five variables: airplane type, cruise altitude range, flight rules (instrument or visual), type of altitude control (manual or autopilot), and pilot experience. Data were collected from eight airplanes representing six airplane types: F-27, Apache, Cessna 337, Beechcraft Musketeer, Cessna 182, and Aero Commander. Most significant among the conclusions drawn was that the altitude deviations are substantially lower when the airplanes are operated with the autopilot. TAB

N67-32540# Booz, Allen and Hamilton, Inc., New York.
SUPERSONIC TRANSPORT FINANCIAL PLANNING STUDY
16 May 1967 234 p refs
(Contract FA-SS-66-23)
(AD-652314) CFSTI: HC $3.00/MF $0.65

The basic purpose of this study was to consider and evaluate the implications of the various means by which the SST program might be financed from completion of the prototype development and flight testing phase (i.e., Phase III) through the certification and production phases (i.e., Phases IV and V). The quantitative data used herein were developed and furnished by the Office of Supersonic Transport Development of the Federal Aviation Agency in a manner consistent with other studies which were being conducted concurrently with this one. Based on these data, a series of cash flow analyses was made under a variety of assumed conditions, in order to postulate the financial feasibility of the program at key points. These analyses focused primarily on the SST manufacturers and airlines financing requirements implicit in a 500 SST airplane program, considered by the FAA as the most likely outcome. The indicated results are, of course, heavily dependent upon the base data and the assumptions employed. It should be emphasized that the findings of the report should be used qualifiedly, i.e., to indicate the range of the financing requirements under various assumptions, the conditions under which the participants might obtain and/or provide financial support, and the broad circumstances under which various financing arrangements might be used. Author (TAB)

N67-32553*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 1.60 TO 2.86 OF THE STATIC AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC TRANSPORT CONFIGURATION WITH VARIABLE-SWEEP WINGS EMPLOYING A DOUBLE INBOARD PIVOT

David S. Shaw and William P. Henderson Washington, NASA, [1962] 42 p refs

(NASA-TM-X-745) CFSTI: HC $3.00/MF $0.65 CSCL 01C

(Declassified)

An investigation was made in the Langley Unitary Plan wind tunnel to determine the supersonic aerodynamic characteristics of a double-inboard-pivot, variable-sweep, supersonic transport (SCAT 12-B) model. Tests were made at Mach numbers from 1.60 to 2.86 and at angles of attack from −6° to 11°. The test Reynolds number per foot was about 2.50×10^6. The results indicate that the model is longitudinally stable at all supersonic test Mach numbers from 1.60 to 2.86 and at the test Mach number of 2.86 yields an untrimmed maximum lift-drag ratio $(L/D)_{max}$ of about 5.2. At test Reynolds number, the model with canard on yielded a trimmed L/D of about 3.9; however, with a reduction in static margin of about 0.06 mean aerodynamic chord, a trimmed L/D of about 5.1 was realized. As wing sweep was reduced from 75° to 60°, the increase in minimum drag overshadowed the reduction in drag due to lift and resulted in lower $(L/D)_{max}$. In the overall test Mach number range, the packaged engine arrangement appeared to be superior to the separate podded engines from the standpoint of aerodynamic efficiency. Author

N67-32554*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

LOW-SPEED LONGITUDINAL STABILITY CHARACTERISTICS OF A SUPERSONIC TRANSPORT CONFIGURATION WITH VARIABLE-SWEEP WINGS EMPLOYING A DOUBLE INBOARD PIVOT

William P. Henderson Washington, NASA, [1963] 52 p refs

(NASA-TM-X-744) CSCL 01C (Declassified)

The investigation was made in the Langley high-speed 7- by 10-foot tunnel. Tests were made at a dynamic pressure of 100 pounds per square foot and at angles of attack from −2° to 24°. The test Reynolds number, based on the mean aerodynamic chord, was 2.04×10^6. The effects of canard, horizontal tails, wing sweep, and engine arrangements on the longitudinal aerodynamic characteristics are presented. The effect of adding fixed area (fore wings) to the 35° sweptback wing is also presented. Author

N67-32558*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

LOW-SPEED INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A VARIABLE-SWEEP SUPERSONIC TRANSPORT CONFIGURATION HAVING A BLENDED WING AND BODY

William C. Sleeman, Jr. and A. Warner Robins Washington, NASA, [1961] 63 p refs

(NASA-TM-X-619) CSCL 01C (Declassified)

A wind-tunnel investigation was made to study the static longitudinal and lateral stability characteristics of a variable-sweep supersonic transport model. The tests were conducted at a Mach number of approximately 0.20 and the angle-of-attack range generally extended from −4° to 23°. The test Reynolds number based on the model reference chord was approximately 2.91×10^6. Author

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-31505*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.

NIMBUS-B SOLAR CONVERSION POWER SUPPLY SUBSYSTEM Quarterly Technical Report, Dec. 1966–Feb. 1967

14 Apr. 1967 63 p

(Contract NAS5-9668)

(NASA-CR-86660; AED-R-3164; QTR-6) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Development of various components of the Nimbus B solar conversion power supply system is considered. Systems engineering efforts focused on preparing documentation for the power subsystem performance specification and instruction manual, and updating of the Nimbus-B energy balance computer program. Testing of the control and storage modules is discussed. A new platform-temperature telemetry circuit was designed, and effects of long-term storage on solar platforms was investigated. Ground checkout equipment and test documentation is discussed as well as engineering reliability and failure modes. Future studies in the areas of the power subsystem, control and storage modules, and engineering reliability are mentioned. S.P.

N67-31525*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL INVESTIGATION OF PARTIAL- AND FULL-ADMISSION CHARACTERISTICS OF A TWO-STAGE VELOCITY-COMPOUND TURBINE

Thomas P. Moffitt and Frederick W. Klag, Jr. Washington, NASA, Oct. 1960 22 p refs

(NASA-TM-X-410) CFSTI: HC $3.00/MF $0.65 CSCL 21E

(Declassified)

The addition of an impulse-type second stage downstream of a single-stage supersonic turbine resulted in an increase in turbine work output of 22 percent at design speed and pressure ratio. At full admission, the equivalent specific-work output obtained from the two-stage turbine at design speed and pressure ratio was 41.0 Btu per pound at a static efficiency of 0.529. No penalty in two-stage performance was obtained when the arc of admission was varied from full admission down to 12.5-percent admission. Author

N67-31528*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DESIGN AND EXPERIMENTAL INVESTIGATION OF TWO ROTOR BLADE MODIFICATIONS FOR A HIGH-WEIGHT-FLOW, LOW-PRESSURE RATIO TURBINE

Robert R. Nunamaker, Donald A. Petrash, and Charles A. Wasserbauer Washington, NASA, Sep. 1969 25 p refs

(NASA-TM-X-7) CFSTI: HC $3.00/MF $0.65 CSCL 21E

(Declassified)

An overall experimental performance investigation was conducted on two rotor blade modifications to an aerodynamically designed rotor blade. These modifications were designed to place greater emphasis on the mechanical characteristics of the blades. A comparison of these results to those previously obtained for the aerodynamically designed blade revealed: (1) Mechanically supporting adjacent blades with pins caused a 0.04 decrease in the design-point efficiency. (2) A redesigned blade shape had essentially no detrimental effect on turbine performance. Author

N67-31832*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
MANNED MISSION PHOTOVOLTAIC POWER SYSTEM STUDY. VOLUME II: TECHNICAL DISCUSSION
9 Jun. 1967 519 p refs
(Contract NAS9-5266)
(NASA-CR-65657; AED-R-3155, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Major problems associated with large scale solar array power systems were defined; and power system studies resulting in conceptual designs adaptable to a variety of missions were performed. System concepts considered included an integrated power system (IPS) and a power system module (PSM). Ground rules and guidelines for the IPS and PSM are given. The mechanical system analysis concepts included stowage and array structure analyses, deployment, component structural design, weights, thermal control, and satellite orbit configurations. Information regarding the studies to be used on computer programs is presented. Also discussed are the electrical systems of the concepts. Tradeoff studies were also conducted. L.S.

N67-31837*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
MANNED MISSION PHOTOVOLTAIC POWER SYSTEM STUDY. VOLUME III: SUPPORTING DOCUMENTATION
9 Jun. 1967 189 p refs
(Contract NAS9-5266)
(NASA-CR-65658; AED-R-3155, Vol. III) CSCL 10A

The ground rules and assumptions applicable to a power system stowage tradeoff analysis in which four basic array-stowage concepts (none of which involve a change in the LEM shroud) were compared, are listed. Conclusions and recommendations are made. Parametric data tables listing the inputs and outputs for solar array, battery, and electronic type power systems, are presented. A computer program designed to perform a large number of calculations, and to aid in establishing the electrical design of a power system for a manned orbiting vehicle, is given. Because of the complexity of the calculations, the program is divided into a main program called MAIN, and the following subrouting programs: STINT, PHI, DEGRAD, STASH, INVERT, PWM, BATTRY, CHARGE, ARRAY, WTVOL, and OUTPUT. The program logic is described. In addition, calculations for the lubricant loss rate through a labyrinth seal are presented; and work concerning the study of fluxes in naturally occurring and man-made space radiation environments, is reported. L.S.

N67-31855 Technical Univ. of Prague (Czechoslovakia). Coll. of Automatic Control.
OPTIMAL DESIGN OF THE CONTROL JET OF A FLUID AMPLIFIER
Pavel Drazan 1967 8 p Presented at the 2d Cranfield Fluidics Conf., Cambridge, 3–5 Jan. 1967
(B2)

A method of optimally designing a pneumatic amplifier control jet to obtain the maximum logic gain of the amplifier connected into a logic circuit is discussed. A graphical method is given for checking the predictions. Author

N67-31876# Zurich Univ. (Switzerland). Swiss Federal Inst. of Technology.
THEORY OF CURRENTS AND VOLTAGES OF A RECTIFIER OR INVERTER CONNECTED TO A SYNCHRONOUS MACHINE
Mohamed Abdelrahman Mansour (Ph.D. Thesis) 1966 135 p refs *Its* Dissertation No. 3773
CFSTI: HC $3.00/MF $0.65

The ideal case of a synchronous machine-rectifier or inverter circuit with conditions of zero resistance damper windings, no leakage, and infinite smoothing coil inductance on the dc side of the rectifier or inverter is considered. The synchronous machine equations were derived making use of the two-reaction theory. The loci of the terminal voltage of the synchronous machine are derived for different parameters, and the static stability limiting curves are obtained. The external characteristics of the synchronous machine for different parameters, as well as the static stability region in the external characteristics plane are derived. The synchronous machine-rectifier or inverter combination is examined, and the operation region of the combination is found to be a small part of the stable region of the synchronous machine so that compensation is found to be desirable. Effects of compensation in both the direct and quadrature axes are investigated as well as the effect of the damper winding resistances, the leakage reactance, and the finite smoothing coil. S.P.

N67-31959# Sud-Aviation, Marignane (France).
SAFETY PROBLEMS IN THE CONSTRUCTION OF ELECTROHYDRAULIC SERVOSYSTEMS IN THE STEERING SYSTEM [SICHERHEITSPROBLEME BEIM AUFBAU ELEKTROHYDRAULISCHER SERVOSYSTEME IM STEUER-SYSTEM]
M. Roger Copée et al *In* WGLR Rept. on the Session of the WGLR Subcomm. on Flight Control Oct. 1966 p 61–98 (See N67-31956 18-02)

Described is an electrohydraulic servomotor system that encompasses a gyro and compensates stick force deviations to such an extent that the aircraft responds in all situations evenly to pilot commands. In contrast to the autopilot system, the stick itself is not regulated by the servomotor. This nonreversible, electronic steering system consists of three independent control channels and thus possesses a very low failure probability. Most of the elements in the stabilization open channel, signaling circuit, and servo control unit are doubled to insure proper functioning. Transl. by G.G.

N67-32006*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
CONCEPTUAL MECHANIZATION STUDIES FOR A HORIZON DEFINITION SPACECRAFT ELECTRICAL POWER SUBSYSTEM
Otto L. Jourdan et al May 1967 175 p refs Prepared jointly with Gulton Industries, Inc., and Spectrolab, Inc.
(Contract NAS1-6010)
(NASA-CR-66378) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A solar cell-battery electrical power subsystem was developed which is compatible with the Horizon Definition Study spacecraft. This subsystem is capable of delivering 70 watts of continuous electrical power for one year in a sun-synchronous, 3 o'clock nodal crossing, 500 km orbit. Author

N67-32037*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
SOLAR POWER SYSTEMS FOR SATELLITES IN NEAR-EARTH ORBITS
C. M. Mac Kenzie Mar. 1967 30 p refs Presented at the IEEE 6th Photovoltaic Specialists Conf., Cocoa Beach, Fla., 28–30 Mar. 1967 Submitted for publication
(NASA-TM-X-55828; X-716-67-77) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Solar conversion and energy storage power systems of the Explorer XXXIII, Nimbus I, and Applications Technology Satellite (ATS-I) are described. Although the basic concepts of all three systems are identical, implementation of these concepts varies with parameters such as attitude, stabilization, and mission. Each system is, therefore, discussed with respect to mission objectives, solar array, battery, power control and distribution, and performance. Attention is given to undervoltage and load switching, the prime converter, and telemetry sensors for the Explorer power system; and battery-discharge control, current sensors, solar array voltage limiter units, and bus paralleling relay for the ATS-1. M.W.R.

N67-32091*# Ryan Aeronautical Co., San Diego, Calif.
DESIGN AND FABRICATION OF A DEPLOYABLE LARGE AREA SOLAR CELL ARRAY SUPPORTING STRUCTURE Final Report
28 Apr. 1967 73 p refs Prepared for JPL
(Contracts NAS7-100; JPL-951107)
(NASA-CR-86986; Rept.-20869-3) CSCL 10A

Reported is the design, development, and fabrication summary for a large area, deployable solar cell structure to be used with an Atlas/Centaur launch vehicle. The device encompasses a roller drum-extendable beam concept of good self-damping qualities, and a four-element deployable array structure containing cells, filters, modular wiring, and secondary cabling. This 50 square foot prototype structure has been fabricated to demonstrate the feasibility of the design concept and the deployment system. All structures and materials utilized are compatible with environmental and space flight requirements of minimum shroud volume. G.G.

N67-32092* Idaho State Univ., Pocatello. Dept. of Chemistry.
THE REACTIONS PERTAINING TO ZINC–SILVER AND CADMIUM–SILVER BATTERIES Quarterly Report
G. Myron Arcand 21 Jun. 1967 9 p refs Prepared for JPL
Revised
(Contracts NAS7-100; JPL-951887)
(NASA-CR-86987; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The insoluble product formed by electro-oxidation of Zn in neutral KNO_3 is about 50% $Zn(OH)_2$. Heavily amalgamated Zn produces an anode which discharges at a reasonable rate. The An(Hg) electrode shows promise as a high-rate anode. High quality AgO was produced electrochemically and approximate activation energies for thermal decomposition of AgO and Ag_2O were determined. Author

N67-32093*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
ANALYSIS OF THE ADVANCED NIMBUS POWER SYSTEMS
Charles N. Bolton and Paul S. Nekrasov (RCA, Princeton, N. J.)
Jul. 1967 34 p refs
(NASA-TM-X-55852; X-716-67-350) CFSTI: HC $3.00/MF $0.65 CSCL 10A

This second-generation solar-conversion power supply, capable of delivering regulated loads between 50 and 500 watts in a 600-n.m. high score sun-sync orbit, includes improved methods of charge regulation, in addition to the use of the advance voltage regulator (AVR), a pulsewidth-modulated (PWM) regulator. The use of a PWM regulator requires a detailed system analysis which includes the investigation of multiple operating points and lockup. A generalized approach to investigating multiple operating points indicates that there are no series lockup modes for the Nimbus B mission. As a follow-on to the more efficient advance voltage regulator, a third-generation concept of Nimbus power-supply subsystems is being investigated which includes the most recent advances in power-conditioning technology, known as maximum power-point tracking. Comparison of Nimbus B with the several system approaches to maximum power-point tracking reveals possible advantages from this mode of operation. Author

N67-32094# National Bureau of Standards, Washington, D. C.
ELECTRODELESS ELECTROLYSIS OF SOLID ELECTROLYTES, DECEMBER 1966–JUNE 1967
Abner Brenner and John L. Bligh 21 Jul. 1967 6 p

Techniques for electrolyzing solid salts, glasses, and ceramics are evaluated. These unique techniques permit electrolysis without either the metallic positive or negative electrical lead contacting the electrolyte. One process called electron beam electrolysis uses a heated tungsten filament to produce electrons. Another type of electrolysis involves use of a glow discharge to traverse the space between the two electrical leads and the electrolyte. Efforts were concentrated on the glow discharge procedure, since it eliminates the electrode–electrolyte contact problems and requires less preliminary preparation than the electron beam method. After electrolysis using the glow discharge technique ceramic discs exhibited a color change and were slightly conductive on the surface. Glass underwent a dramatic physical transformation, becoming opaque and white on the surface. A clear disc of sodium chloride cut from a single crystal was also successfully electrolyzed. S.P.

N67-32147*# IIT Research Inst., Chicago, Ill.
DESIGN GUIDE FOR PRESSURIZED GAS SYSTEMS, VOLUME II
Mar. 1966 438 p refs Revised
(Contract NAS7-388; IITRI Proj. C8070)
(NASA-CR-86590) CSCL 22B

Thermodynamic and physical property data for gases to be used for pressurizing spacecraft or missile systems, or for use in attitude control systems, are presented. Density data of thirteen gases; nitrogen, hydrogen, helium, oxygen, carbon dioxide, water, propane, n-butane, ammonia, and the four freons, are graphically presented. Other gases for which data are presented are perchloryl fluoride, chlorine trifluoride, hydrazine, nitrogen tetroxide, unsymmetrical dimethyl hydrazine, and hydrogen peroxide. L.S.

N67-32148*# IIT Research Inst., Chicago, Ill.
DESIGN GUIDE FOR PRESSURIZED GAS SYSTEMS, VOLUME I
Mar. 1966 801 p refs Revised
(Contract NAS7-388; IITRI Proj. C8070)
(NASA-CR-86591) CSCL 22B

Conversion tables for data used in the design of pressurized gas systems for spacecraft are presented, and a general discussion of pressurized gas systems is given. Available information on the composition of the atmosphere, including data on the distribution of meteoroids and various types of radiation encountered by spacecraft, is summarized. The behavior of liquids in an essentially gravitationally free system with respect to pressurized gas systems is discussed. Salient principles underlying the design of pressurized gas attitude control systems are presented. Computations of the performance of fluids expanding through nozzles (considering both condensable and noncondensable gases), are summarized. Design criteria for pressure vessels are established, and the various materials and fabrication methods currently used for pressure vessels are discussed. Fundamental aspects of diffusion and permeability theory; detection of leaks and sealing; leakage calculations; and fluid system components are discussed. Definitions of storage and weight efficiency are given. Heat balance in a spacecraft; reliability guidelines for a test program; and gas properties, are discussed. L.S.

N67-32171# Naval Civil Engineering Lab., Port Hueneme, Calif.
PORTABLE TOTAL ENERGY PACKAGE FOR ADVANCED BASE FUNCTIONAL COMPONENTS Final Report, Jun.–Sep. 1966
John S. Williams Jun. 1967 49 p refs
(TR-530; AD-653081) CFSTI: HC $3.00/MF $0.65

Under consideration is the concept of a total energy package consisting of a gas-turbine-driven generator and a waste-heat boiler for use in the advanced base functional component system. The results of a survey show that a total energy package will probably not provide balanced heat and electrical energy demands, making the small gas turbine a poor logistic and economic choice for a prime mover. Suggestions are offered for the utilization of waste heat from diesel generators, where feasible. Included in the report as an Appendix is a literature study of high-temperature corrosion of turbine blading in a marine atmosphere. Author (TAB)

N67-32178* Brown Univ., Providence, R. I. Div. of Engineering
PHOTOVOLTAIC EFFECT AND UTILIZATION OF PHOTOVOLTAIC CELLS Fourth Semiannual Report, 1 Jan.–30 Jun. 1967
J. J. Loferski and W. Giriat Jul. 1967 24 p refs
(Grant NGR-40-022-026)
(NASA-CR-86918; SAR-4) CFSTI: $3.00 CSCL 10A

The effects of 115 keV electron irradiation on the short circuit current I_{sc} produced in silicon photovoltaic cells by strongly absorbed light ($\alpha \approx 10^5 cm^{-1}$) has been studied in the organic-vapor free vacua provided by a Vac-Ion pumping system. It is shown that the behavior of I_{sc} (and by inference, of surface recombination velocity) is a function of the resistivity of the bulk material whose surface is being irradiated. It is shown that irradiation in an organic-vapor free vacuum of 10^{-6} mm Hg by about 10^{15} electrons/cm^2 leads to a surface which is stable for long periods (about 20 hours) of time in contrast to the situation associated with irradiation in organic-vapor contaminated ambients where changes in I_{sc} begin to occur as soon as the electron beam is interrupted. Author

N67-32180*# David Sarnoff Research Center, Princeton, N. J. Astro-Electronics Applied Research Lab.
REVIEW AND EVALUATION OF PAST SOLAR CELL DEVELOPMENT EFFORTS
P. A. Crossley, G. T. Noel, and M. Wolf Jun. 1967 85 p refs
(Contract NASw-1427)
(NASA-CR-86979) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A bibliography of scientific papers related to the photovoltaic effect is presented, and a historical review of scientific investigations of this effect during the years 1839–1940 is given. Topics covered include the Becquerel effect, the barrier photovoltaic effect, and the Dember effect. Because of its historical importance, major emphasis has been placed on the barrier photovoltaic effect as seen in copper–cuprous oxide photocells. All experimental investigations as reported in the literature have been covered, and the development of the modern theory of the photovoltaic effect is described. Author

N67-32259* Naval Ammunition Depot, Crane, Ind.
LIFE CYCLE TESTS Monthly Progress Report, Period Ending 31 Mar. 1967
31 Mar. 1967 189 p
(NASA Order W-11252-B)
(NASA-CR-85976) CSCL 10C

Results of life cycle test data for partial and total space cell packs which were compiled for NASA's space cell test program are reported. Tests of nickel–cadmium 10- and 5-cell packs from the following manufacturers are presented: General Electric Company; Gould-National Batteries, Incorporated; Sonotone Corporation; and Gulton Industries, Incorporated. Capacity and failure test data analyses are included. Data sheets which give end of discharge and end of charge voltage readings for each cell on each cycle recorded are also included. S.C.W.

N67-32288 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONCERNING THE USE OF TWO-PHASE SYSTEMS AS A THERMODYNAMIC WORKING MEDIUM
I. T. El'perin and V. A. Minkov *In its* J. of Eng. Phys. 17 Mar. 1967 p 53–62 refs (See N67-32281 18-34)

A thermodynamic analysis of cycles of thermopower plants with two-phase working substances is conducted. It is shown that application of such working substances promotes increase of efficiency and specific work of the cycle. Author

N67-32383*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
GEOMETRIC EFFICIENCY OF AN ELECTROFORMED NICKEL SOLAR CONCENTRATOR
Conrad M. Willis and O. Karl Houck Washington, NASA, Aug. 1967 32 p refs
(NASA-TN-D-4072) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Geometric efficiency of a 152-centimeter-diameter paraboloidal solar-energy concentrator was calculated from optical-ray-trace data. The data were obtained by reflecting a beam of light, which was parallel to the concentrator axis, from the concentrator to a focal-plane image plate and measuring image displacement from the concentrator axis. Two of the three methods used to calculate efficiency provided results that were within 0.025 of the measured calorimetric efficiency for energy-absorber apertures larger than 1-3/4 solar-image diameters. The data were also used to calculate the slope errors of the concentrator reflective surface. The values of one standard deviation of slope error were 1.45 milliradians for the radial component and 2.32 milliradians for the circumferential component. Author

N67-32514# Burgess Battery Co., Freeport, Ill.
DEVELOPMENT OF MAGNESIUM WAFER CELLS Quarterly Report, 1 Nov. 1966–31 Jan. 1967
Lloyd W. Eaton Apr. 1967 19 p
(Contract DA-28-043-AMC-02135(E))
(Rept.-3; QR-3; ECOM-02135-3; AD-652698) CFSTI: HC $3.00/MF $0.65

A hypothesis was developed that the construction of the inter-cell connector provided free space within the battery and that gassing within the cell, during storage at elevated temperature, caused the cell wrap to balloon into this free space and partially lift the cathode collector off the cathode mix, causing a high resistance. This resistance would then increase when the battery is on discharge due to the additional gassing which occurs, lifting the cathode collector to where battery failure occurs during the first few hours of discharge. Two new constructions were developed that virtually eliminate the free space within the battery. One of the constructions eliminates the material problem of the intercell connector. Author (TAB)

N67-32515# Sonotone Corp., Elmsford, N. Y.
OPTIMUM STRUCTURES FOR MINIATURE Ni–Cd SEALED CELLS AND BATTERIES Quarterly Report, 11 Nov. 1966–10 Feb. 1967
John Herrmann, Stephan Thornell, and Michael Ruberto May 1967 69 p
(Contract DA-28-043-AMC-02361(E))
(Rept.-2; QR-2; ECOM-02361-2; AD-652700) CFSTI: HC $3.00/MF $0.65

Electrochemical investigations were directed toward evaluation of 1.0 A.H. cylindrical Ni-Cd sealed cells containing pasted negative plates. The investigation also includes an evaluation of the data gathered on 1.0 and 4.0 A.H. cells that were life-cycled at the 5-hour charge rate for 200 cycles. In addition, investigations are included that evaluate charging efficiencies of the sintered positive, sintered negative, and pasted negative plates at the five-hour charge rate. Mechanical investigations were directed towards pressure tests and stress analysis of 0.016 in. thick cylindrical cell cases, geometric progression of cylindrical cells down to 0.5 A.H., geometric proportions of 4.0 A.H. rectangular cells, and battery packaging of a 6 volt, 4.0 A.H. rectangular battery with rectangular cells. Stress analysis data are not conclusive enough to determine a numerical value of unit stress. Author (TAB)

N67-32522*# Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.
MANNED MISSION PHOTOVOLTAIC POWER SYSTEM STUDY. VOLUME I: PROGRAM SUMMARY Final Engineering Report, Apr. 20, 1966–Jan. 20, 1967
9 Jun. 1967 121 p ref
(Contract NAS9-5266)
(NASA-CR-85858; AED-R-3155, Vol. I) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The goals, chronology, and electrical, mechanical, and general ground rule requirements of a program leading toward development of a manned orbiting photovoltaic power system, are presented. Results concerning analyses of the general power system, the Integrated Power System (IPS) and the Power System Module (PSM), are summarized. Electrical, mechanical, and orientation system studies are discussed, along with computer program and parametric, weight studies. Specific conclusions for each of the trade-off studies and analyses performed are presented; and recommendations are made for a development plan, schedule, and budgetary cost estimate for both PSM and solar array/battery system design efforts. L.S.

N67-32524# Burgess Battery Co., Freeport, Ill.
DEVELOPMENT OF CARBON ZINC BATTERIES CAPABLE OF STORAGE AT TEMPERATURES UP TO 160°F Semiannual Report, 1 Jul.–31 Dec. 1966
Terry G. Messing Mar. 1967 29 p
(Contract DA-28-043-AMC-02391(E))
(Rept.-1; SAR-1; ECOM-02391-1; AD-652720) CFSTI: HC $3.00/MF $0.65

High Temperature Carbon-Zinc Development Contract Number DA28-043-AMC-02391(E). Discussion of development of a carbon zinc battery capable of prolonged storage at high temperatures is given. This includes a discussion of and data comparing the wafer cell and the round cell construction. A summary of the ability of the present product at these temperatures is given. The Burgess mechanically sealed cell is described and discussed. And gassing experiments conducted with certain inhibitors are given.
Author (TAB)

N67-32529*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
MULTIKILOWATT SOLAR ARRAYS
D. W. Ritchie and J. D. Sandstrom 15 Jul. 1967 19 p refs
(Contract NAS7-100)
(NASA-CR-87005; JPL-TR-32-1140) CFSTI: HC $3.00/MF $0.65 CSCL 10A

The ever-changing field of photovoltaics has led to significant improvements which enhance its consideration for multikilowatt systems. Specifically, large-area, lightweight structural developments along with new silicon technology indicate the feasibility of multikilowatt solar arrays with specific power densities approaching 40 lb/kw. In addition, thin film technology, namely, CdS-type photovoltaic devices, promises even greater potential in the future. Current development efforts are presented. Author

N67-32550*# Dynatech Corp., Cambridge, Mass.
A GRAVITY INDEPENDENT VAPOR ABSORPTION REFRIGERATOR
J. R. Blutt and S. E. Sadek Jul. 1967 157 p refs
(Contract NASw-1372)
(NASA-CR-836; Rept.-695) CFSTI: HC $3.00/MF $0.65 CSCL 13A

Vapor absorption refrigerator systems were designed to operate independent of gravity. The weights of these systems were determined and were found to be competitive with the weights of semi-passive and vapor compression systems of the same ratings. A critical design evaluation of all major components was conducted in order to determine the feasibility of operating independent of gravity. Analog and/or model component tests were conducted to demonstrate the lack of dependence on gravity. Two reference systems were designed. A portable thermal control system for cooling a spacesuit during extravehicular activities resulted in an 89-pound system with a total radiator area of 27 ft^2 for a 2500 Btu/hr. cooling capacity. The second reference design was a refrigerator for cooling a thermal radiation shield protecting cryogenic storage tanks. The system has 1 KW cooling capacity at −40°F and weighs 242 pounds. Author

N67-32562*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
THE DESIGN OF A THREE-STAGE POTASSIUM TEST TURBINE. VOLUME I: FLUID DESIGN
R. J. Rossbach, G. C. Wesling, and W. F. Lamond [1967] 90 p refs
(Contract NAS3-8520)
(NASA-CR-72249) CSCL 10A

A three-stage potassium vapor turbine has been designed for testing in the existing 3000 KW facility with 1550°F inlet vapor temperature. The turbine is designed for 15,000 hours operation with eight to ten percent liquid entering the third stage which has a tip speed of 835 ft./sec. This turbine is a growth version of the successful two-stage potassium turbine and is based on the same design principles. The additional stage and more extensive instrumentation are expected to provide better understanding of wet potassium vapor turbines. Author

N67-32595*# Electro-Mechanical Research, Inc., Sarasota, Fla.
THERMAL LABORATORY, SECTION II Quarterly Progress Report, 1 Dec. 1966–28 Feb. 1967
Malcolm Lillywhite, O. Olesen, D. Lester, G. Enos, L. Hallman, et al. *In* NASA. Goddard Space Flight Center Radiometry Progr. 1st Trimester, 1967 Apr. 1967 17 p (See N67-32594 18-23)
(Contract NAS5-9244)

Operating and upgrading the A1200 solar simulator is discussed, along with efforts at maintaining an electronics support and calibration laboratory and conducting a coatings qualification program. A malfunction that occurred in the simulator during pre-testing is reported in which some of the lamp housing material melted to cause damage to an undercoating. Two types of water-cooled collectors were tested at various power levels in preparation for thermal modifications to the simulator. Some degradation of spectral filters used in the simulator was observed. During the first phase of the total irradiance detector study, five types of detectors were calibrated using an Angstrom Compensation Pyrheliometer. M.W.R.

N67-32677# Bright Star Industries, Clifton, N. J.
ORGANIC DEPOLARIZED CELLS UTILIZING METADINITROBENZENE Quarterly Progress Report, 30 Jun.–15 Oct. 1966
Sol S. Jaffe Oct. 1966 76 p
(Contract DA-28-043-AMC-01401(E))
(ECOM-0140-3; QPR-3; AD-652285) CFSTI: HC $3.00/MF $0.65

The object of the work is to develop and optimize techniques that are readily translatable to production methods for the fabrication of magnesium/magnesium perchlorate/m-dinitrobenzene dry cells in the R(N), A, and D sizes, and to test a quantity of cells so produced. A statistical analysis is presented of the data obtained in the First Factorial Experiment, experimental details of which were reported previously. The results, applicable to A size Mg dry cells made with depolarizer slugs 1.671 inches in height and 0.503 inch in diameter, show that minimal leakage is obtained with the fold-over separator construction and the lower level of wetness (1.75 ml of 1.25M Mg(C1O4)2 per gm of practical grade m-dinitrobenzene, as supplied); but that output is greater at the higher level (2.00 ml per gm). A Second Factorial Experiment is described, one of the purposes of which was to establish whether the inferior performance (greater leakage and somewhat poorer output) which is characteristic of the disk-and-washer separator, when used in conjunction with a slug of the dimensions indicated, is associated with its design at the top or at the bottom—its design at the sides being identical with that of the fold-over separator. Using separators of mixed design, it was established that the deficiency disappears when slug height is reduced to 1.546 inches. Cells so made give about 26.4 hours of output (±0.2 hours) with minimal leakage, and behavior is not affected by variations in electrolyte level (within the range 2.00 to 2.20

ml per gm) of technical grade m-dinitrobenzene (as supplied with 17% H_2O); nor by variations in separator construction (within the range studied); nor by the presence or absence of smears. TAB

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-31500# National Institutes of Health, Bethesda, Md. Translating Unit.

EXPERIMENTAL PRODUCTION OF HEMAGGLUTININS AND PRECIPITINS IN HELIX POMATIA

J. Cantacuzene 8 Jun. 1967 4 p Transl. into ENGLISH from Compt. Rend. Soc. Biol. (Paris), v. 79, 1916 p 528–530

Studied was the production of antibodies in Helix pomatia that had received erythrocytes from mammals by stomach ingestion or subcutaneous injection. Rabbit blood used as an antigen was readily ingested by the snails, but they showed reluctance when goat blood was used. A large snail gave 1 cc of blood by gastric puncture. Whereas the blood of normal snails has no agglutinating, precipitating, or hemolytic effects, they were developed after ingestion or injection of erythrocytes. Specific findings are listed which prove that agglutinating and precipitating antibodies may form in invertebrates. However, as has been found previously, their production requires a far longer time than in vertebrates with either a variable or constant temperature. K.W.

N67-31636 National Institutes of Health, Bethesda, Md. Translating Unit.

RELEASE OF POTASSIUM FROM MUSCLES UNDER THE EFFECT OF SOME MUSCLE RELAXANTS

H. Klupp and O. Kraupp [1954] 18 p refs Transl. into ENGLISH from Arch. Intern. Pharmacodyn. (Ghent), v. 98, no. 3, 1954 p 340–354

(Rept.-4-4-67)

To investigate whether the depolarization of the end-plate region produced by C 10-like substances was also accompanied by a passage of potassium from the muscle fiber into the extracellular space, an animal study was conducted with succinyldicholine (M 115), decamethonium (C 10), and octamethylene dicarbaminoylcholine (BC 9). The experiments reported here led to the result that after administration of decamethoniumlike muscle relaxants, potassium ions are liberated from the cross-striated muscles. The potassium excretion observed after high doses of ACh was much weaker than that found after administration of muscle relaxants. It was established that after preliminary treatment with eserine, the effect of ACh on the potassium liberation from the musculature was considerably increased. The inhibitory effect of curare on the potassium liberation was present even after 5 hours, although at this time the muscle-paralyzing effect of curare itself had completely disappeared. R.Li.

N67-31641*# Stanford Univ., Calif. Lab. of Human Neurophysiology.

ELECTROPHYSIOLOGICAL CORRELATES OF VIGILANCE AND LEARNING Progress Report, Jul. 1966–31 May 1967

Frank Morrell and Lenore Morrell May 1967 15 p refs

(Grant NsG-215)

(NASA-CR-85843) CSCL 06P

Reported are electrophysiologic studies which center upon understanding neural mechaniams mediating human performance and perception. Specifically investigated were temporal parameters of sensory interaction, studied simultaneously by behavioral and electrographic means. The work was motivated by two lines of inquiry: (1) experimental psychology findings that polysensory stimuli modify behavior and perception with respect to a signal in a given sense mode; and (2) studies of polysensory convergence at single neurons and the unit and evoked potential demonstrations of polysensory facilitation and inhibition. It was found that an auditory stimulus coming after a visual stimulus to respond has a facilitating effect upon visual reaction time which tends to decrease linearly with interstimulus interval. The range investigated was 20–120 msec. One series involved a random presentation of flash-click pairs at various interstimulus intervals and occasionally flash alone. A second series used choice reaction time of the classic c-reaction type: occasionally click alone is presented and response is to be withheld. The addition of choice led to essentially similar or even more consistent results. Some studies on simultaneity–successivity judgments in the bisensory situation are also discussed. K.W.

N67-31642*# Hawaii Univ., Honolulu. Geochemistry Div.

SEARCH FOR BIOLOGICAL PRECURSOR MOLECULES IN VOLCANIC VOLATILE SYSTEMS Semiannual Status Report, Sep. 1966–Mar. 1967

John J. Naughton Mar. 1967 7 p

(Grant NGR-12-001-012)

(NASA-CR-85612) CFSTI: HC$3.00/MF$0.65 CSCL 06C

The purpose of the research is: (1) to investigate the natural volcanic gaseous system for its elemental and molecular composition, with emphasis on compounds of biological importance present in trace quantities; and (2) field and laboratory investigations of the equilibrium molecular and free radical components found in gaseous systems containing the major elements of volcanic gas. Work on Hawaiian volcanoes showed that the gases are a homogeneous system in thermodynamic equilibrium. Pockets or vesicles of gas in newly erupted lavas and of similar gaseous or fluid inclusions in ultrabasic nodules were investigated for presence of prebiotic components. Collection of gases was continued at Makaopuhi lava lake and at the Sulfur Bank and Aloi fumarole sites. A drilling program at the Kilauea Iki lake is briefly described, and inorganic volatiles were collected from the drill holes of Makaopuhi lava lake. Gas chromatographic analyses of collected gases failed to reveal carbon-containing substances except for carbon dioxide and methane; however, an occasional peak in the flame ionization detector seemed to indicate carbon compounds of an unknown nature, and a mass spectrometer analysis is planned. K.W.

N67-31644# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

PHYSICAL SCIENCES. VOLUME 2: RADIOLOGICAL SCIENCES Annual Report, 1965

D. W. Pearce and J. K. Green, ed. May 1966 178 p refs

(Contract AT(45-1)-1830)

(BNWL-235-2) CFSTI: HC$3.00/MF$0.65

Progress is reported on the following studies in radiological physics: fast pulse averaging; time-resolved spectroscopy; specific ionization of monoenergetic protons in tissue-equivalent gas; grid-walled proportional counter; self absorption in scintillation crystals; pulsed X-ray machine; local energy density and hit theory; long term change of Pu–Be neutron sources; local-energy-density distributions; calorimetric measurements; absorbed-dose-calorimetry; fast neutron medical research facility; tissue equivalent ion chamber development; calculation of the distribution of dose in linear energy transfer from spherical proportional counter data; low energy fast neutron spectrometer; transition zone dosimetry; whole body counting of plutonium in dogs; short-term retention of plutonium in dogs; plutonium whole body counting; ^{55}Fe in the marine environment and in people who consume ocean fish; seasonal cycle of ^{137}Cs in Alaskan natives at Anaktuvuk pass; the application of simplified whole body counting in Alaska. Progress is reported on the following studies in radiation chemistry: determination of

erythrocyte size distribution; radiation-induced hemolysis of erythrocytes; effect of chloride ion on the radiolysis of erioglaucine solutions; electron spin resonance detection instruments; ^{60}Co irradiator flow system for electron spin resonance; long-lived organic radicals formed in irradiated aqueous solutions; reaction kinetics of free radicals in aqueous solution; chemical protection of agarose jellies from radiation damage. Progress is reported on the following studies in radiological chemistry: alpha-emitters in the Columbia river; the reduction of reactor effluent water radionuclide concentrations by the addition of sodium silicate to process water; the effect of reduced alum addition on the removal of ^{75}As at the KW-Reactor water treatment plant; ion exchange studies of the chemical form of radionuclides in Columbia river water and reactor effluent; determination of seasonal variations in sediment deposition rates in McNary Reservoir of the Columbia River; the use of $^{65}Zn/^{60}Co$ ratios to determine age and deposition rate of river bottom sediments; a method for determination of ^{32}P and other radionuclides on filters containing suspended river sediments; behavior and transport of radionuclides in the Columbia River between Hanford and Vancouver, Washington; natural and artificial radionuclide concentration in farm produce irrigated with Columbia River water; distribution and excretion of technetium in humans; ^{210}Pb and ^{210}Po in Alaskan biological samples; the distribution of natural and artificial radionuclides through the food chain in Alaska; ultrasensitive measurement of radionuclides and trace element constituents in the ocean by multidimensional gamma-ray spectrometry; cosmic-ray produced radionuclides in the environment; trace element measurements in snow; concentration of fallout radionuclides during wet and dry seasons; airborne radionuclides measurement; ^{133}Xe as an atmospheric tracer; the measurement of ^{131}I transport in atmospheric diffusion experiments; organic ^{131}I compounds released from a nuclear fuel chemical processing plant; fission product aerosol behavior in the plutonium recycle test reactor fuel rod failure of September 29, 1965; a simplified method for the determination of trace elements in geologic samples by activation analysis; identification of individual basalt flows by activation analysis; trace element impurities in vitreous silica tubing; preliminary evaluation of an existing multidimensional gamma-ray spectrometer for whole body counting; an anticoincidence-shielded Ge(Li) gamma-ray spectrometer; redesign and application of an anticoincidence-shielded Ge(Li) gamma-ray spectrometer; evaluation of radiochemical methods for biological purposes; determination of elements in wheat grain by neutron activation analysis and multidimensional gamma-ray spectrometry; selective and sensitive analysis of activation products by multidimensional gamma-ray spectrometry; gamma-ray background studies for NaI(Tl) and plastic detectors; gamma-ray transitions in ^{58}Fe; trace elements in cancerous and non-cancerous human tissues. NSA

N67-31668# Library of Congress, Washington, D. C. Aerospace Technology Div.

HYDROCARBON-UTILIZING MICROORGANISMS

Lee Perkins *In its* Foreign Sci. Bull., Vol. 3, No. 5 May 1967 p 11-19 refs (See N67-31666 18-34)

Many microorganisms living in environments in which hydrocarbons are the sole carbon source have been screened for their potential use in the decontamination of industrial sewage, in petroleum exploration, and in vitamin and growth-stimulant production. Their physiology and ecology are potentially useful in metabolic, ecological, and genetic research, and for selective breeding to yield strains adapted to specific environments and functions. Author

N67-31725*# California Univ., Berkeley. Dept. of Nutritional Sciences.

NUTRITIONAL REQUIREMENTS AND BREEDING BEHAVIOR OF PEROGNATHUS Semiannual Progress Report, Jan. 1-Jun. 30, 1967

Rosemarie Ostwald 30 Jun. 1967 7 p

(Grant NGR-05-003-118)

(NASA-CR-85777) CSCL 06C

A semi-synthetic diet adequate for long-term maintenance of adult *P. penicillatus, longimembris,* and *intermedius* was developed. The presence of a high ratio of K/Na, Mg/Ca and the substitution of inorganic phosphates by glycerophosphate turned out to be the crucial factors for success. Female *P. penicillatus* can be brought into breeding condition by three methods: (1) treatment with pregnant mare serum; (2) exposure to a sequence of winter and spring conditions in an environmental chamber; and (3) visual or olfactory contact with males in screen-divided cages. Eleven litters comprising approximately 50 pups have been produced, of which one litter was by method (1), two by method (2), and eight by method (3). Two additional litters were obtained from mice who had come spontaneously into estrus. Diet compositions and temperature, humidity, and light schedule of the environmental chamber are shown in tables. K.W.

N67-31733*# Farnham (Frank C.) Co., Philadelphia, Pa.

THE EFFECT OF ELECTROMAGNETIC AND MAGNETIC FIELDS ON THE CENTRAL NERVOUS SYSTEM

Yu. A. Kholodov Washington, NASA, Jun. 1967 256 p refs Transl. into ENGLISH of the book "Vliyaniye Elektromagnitnykh i Magnitnykh Poley na Tsentral'nuyu Nervnuyu Sistemu" Moscow, Izd. Nauka, 1966 p 1-280

(Contract NASw-1497)

(NASA-TT-F-465) CFSTI: HC $3.00/MF $0.65 CSCL 06S

The basic approach is to clarify the physiological mechanism of the effect of electromagnetic field on the functions of the brain through the use of electrophysiological and conditioned-reflex methods. In addition, various methods of recording motor activity, determining the sensitivity to electrical and chemical stimuli, and certain morphological methods were used. The experimental objects were different classes of vertebrates, beginning with fish and ending with mammals. Author

N67-31745# Brookhaven National Lab., Upton, N. Y. Biology Dept.

ENERGY CONVERSION BY THE PHOTOSYNTHETIC APPARATUS

Jan. 1967 563 p refs Presented at Brookhaven Symp. on Biol. No. 19, Upton, N. Y. 6-9 Jun. 1966

(Contract AT(30-2)-GEN-16)

(BNL-989-(C-48)) CFSTI: HC $3.00/MF $0.65

Symposium papers on energy conversion by the Z-scheme—includes phosphorylation, electron transfers and flows, oxygen evolution and chlorophyll fluorescence. For individual titles see N67-31746-N67-31784.

N67-31746# Illinois Univ., Urbana. Dept. of Botany.

SPECTRAL PROPERTIES OF CELL SUSPENSIONS

E. I. Rabinowitch, L. Szalay, M. Das, and N. R. Murty *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 1-7 refs (See N67-31745 18-04)

A procedure is discussed for comparing the absorption spectrum of a cell suspension with that of a sonicate (a suspension of cell fragments obtained by ultrasonic treatment). It is pointed out that sonication must be carried out under anaerobic conditions to preclude photooxidation, and in a slightly alkaline buffer to minimize pheophytinization. Figures are included to depict test data showing that the ratio of absorbance values at the peaks of the blue and red band is much higher in the sonicate than in the cell suspension. Also reported are the results of an analysis of the red absorption band in a suspension of *Chlorella pyrenoidosa*; the band is represented by only three Gaussian bands, one attributable to chlorophyll *b* at 650 mμ, and two attributable to chlorophyll *a* at 668 and 683 mμ, respectively. Efforts to exactly determine the red drop in the action spectrum of chlorophyll *a* fluorescence in *Chlorella* were undertaken. Findings indicate that the two main components of the red absorption band do not differ in their contribution to photosynthesis and fluorescence. M.G.J.

N67-31747# Maryland Univ., College Park. Dept. of Physics and Astronomy.

MIGRATION AND TRAPPING OF EXCITATION QUANTA IN PHOTOSYNTHETIC UNITS

Robert M. Pearlstein *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 8–15 refs (See N67-31745 18-04)

Problems of energy transport in photosynthetic pigment arrays are assessed, and the theory that migratory excitation quanta in photosynthetic units are localized excitons is discussed. Several relaxation-time formulas are derived for application to photosynthetic units, and the factors which must be considered for reliably estimating the fundamental rate constant are defined. The experimental quantities to which excitation relaxation is most closely connected are identified as the fluorescence yield and lifetime of the major pigment component. Ways of relating theoretical and experimental quantities for photosynthetic units are considered. M.G.J.

N67-31748# California Inst. of Tech., Pasadena. Gates and Crellin Labs. of Chemistry.

EXCITATION TRANSFER AND TRAPPING IN PHOTOSYNTHESIS

G. W. Robinson *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 16–48 refs (See N67-31745 18-04)

Data on excitation transfer in solids, published in 1938, are reviewed in the light of modern knowledge. The reasons why the Forster R^{-6} transfer mechanism does not apply to excitation trapping in photosynthesis are spelled out. A distinction is made between a puddle model for the photosynthetic apparatus, in which the photosynthetic units (PSU) are not strongly interconnected, and a lake model in which individual PSUs are indistinguishable. Excitation transfer in the PSU, via both a coherent wave packet mechanism and a random walk mechanism, is discussed. Mathematical and physical concepts are introduced to allow better estimates of the photokinetic processes in pigment aggregate systems of the kind represented by the PSU. Consideration is also given to the possible role of triplet states of chlorophyll in the photosynthetic mechanism. Supplementary data are included on the manner in which transitions can occur over the entire breadth of the electronic exciton band at nonzero temperatures, and on an exciton in the tight-binding limit. M.G.J.

N67-31749# Leiden Univ. (Netherlands). Biophysical Lab.

ABSORPTION CHARACTERISTICS OF BACTERIOCHLOROPHYLL TYPES IN PURPLE BACTERIA AND EFFICIENCY OF ENERGY TRANSFER BETWEEN THEM

W. J. Vredenberg and J. Amesz *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 49–61 refs (See N67-31745 18-04)

Infrared absorption spectra of various species were measured at room and liquid nitrogen temperatures with a spectral resolution of 1 mμ in order to resolve bands possibly of new types. The positions of the maxima of the different bands at both temperatures are tabulated, and the absorption spectra for each species are depicted. The results indicate that some species of purple bacteria have more than three absorption bands in the near-infrared wavelength region. Two spectroscopically different types were observed. To estimate the efficiency of energy transfer between the different bacteriochlorophyll types, the near-infrared excitation spectra of bacteriochlorophyll fluorescence were measured. For a few species, action spectra of light-induced absorbance changes were measured for the same samples. Findings show that for some types the efficiency of energy transfer may be <100%, and that different pools of bacteriochlorophyll molecules may exist. The spectra of the light-induced absorbance changes are interpreted as due to shifts of absorption bands around 820, 850, and 870 to 890 mμ. M.G.J.

N67-31750# Cincinnati Univ., Ohio. Charles F. Kettering Research Lab.

THE BACTERIAL PHOTOSYNTHETIC REACTION CENTER

Roderick K. Clayton *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 62–69 refs (See N67-31745 18-04)

The basic concepts for models of the bacterial photosynthetic mechanism are reviewed, and the physical problems peculiar to photosynthesis are defined as the way in which energy is delivered from the light-harvesting system to the reaction centers and trapped there; the molecular species which participate in photochemistry at the reaction centers; and the physical states of bacteriochlorophyll (BChl) or other molecules which are involved in initiating the photochemistry. A simple view of the physical mechanisms in bacterial photosynthesis is presented, in which the photochemical reaction center is built around P 870. This BChl molecule has special properties due to its association with an electron acceptor molecular and a cyctochrome molecule. Details are given on the isolation and characterization of P 870. Data are provided to show: (1) This pigment acts as a trap for excitation energy produced in the light-harvesting BChl aggregate. (2) Rapid photochemical quenching by P 870 assures efficient use of the excitation energy. (3) The fluorescence of BChl reflects a small energy loss during transfer to the P 870. M.G.J.

N67-31751# Leiden Univ. (Netherlands). Biophysical Lab.

PRIMARY PHOTOSYNTHETIC REACTIONS IN RELATION TO TRANSFER OF EXCITATION ENERGY

L. N. M. Duysens *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 71–79 refs (See N67-31745 18-04)

Evidence based mainly on sensitive absorption and fluorescence difference spectroscopy has made it seem probable that the primary photochemical reactions take place in so-called reaction centers, which are molecular complexes consisting of a chlorophyll-like molecule associated with a small number of molecules that can be oxidized or reduced. Of these, only cytochromes have been identified with certainty, but, as discussed, the redox reactions of some other molecules of the complexes can be studied by physical methods. On the basis of certain models, equations are derived describing the relation between the fluorescence and the state of the reaction centers. This state can in some cases be determined from sensitive absorption difference spectrophotometry or from fluorescence spectrophotometry, and the rate of the redox reactions can be determined from the kinetics of the absorption or fluorescence changes. The agreement between predictions based on models and experimental data supports the hypothesis concerning transfer of excitation energy to reaction centers. Author

N67-31752# Carnegie Institution of Washington, Stanford, Calif. Dept. of Plant Biology.

LIGHT-INDUCED REACTIONS OF CHLOROPHYLL *b* AND P 700 IN INTACT PLANTS AND CHLOROPLAST FRAGMENTS

David C. Fork, Jan Amesz, and Jan M. Anderson *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 81–94 refs (See N67-31745 18-04)

Evidence is presented to show that, while chlorophyll *b* is one of the compounds that causes increased absorbance in high plants around 515 mμ, it is not the only substance. Action spectra of *Ulva lobata* show that a fast component of the chlorophyll *b* reaction is produced by system I. System II probably mediates a slower component. Based on previous data that a separation of the two pigment systems can be achieved by detergents, absorbance changes were measured in chloroplast particles treated with digitonin. A comparison is given of the relative amounts of P 700 to chlorophyll for chloroplast fragments, and for the centrifugal fractions obtained by digitonin fragmentation. These results are found to be in agreement with the hypothesis that digitonin brings about a partial separation of systems I and II. M.G.J.

N67-31753# Pennsylvania Univ., Philadelphia. Johnson Research Foundation.

KINETICS OF P 870 ABSORBANCE CHANGES INDUCED IN *RHODOSPIRILLUM RUBRUM* CHROMATOPHORES BY LASER FLASHES

William W. Parson *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 95–101 refs (See N67-31745 18-04)

Measurements were made in frozen suspensions of chromatophores to show the spectrum of the absorbance changes caused by a 30 nsec flash of 6943 Å light from a ruby laser. Also measured were the kinetics of the P 870 absorbance changes at room temperature, and the temperature dependences of the recovery rates. Figures depicting the findings are included. Observations show that very rapid bleaching of P 870 occurs after a flash. It was concluded that recovery occurs in three different ways: (1) Room temperature recovery is kinetically complex; part of it is sensitive to heat and inhibitors, and probably involves cytochromes. (2) Low temperature recovery is unaffected by treatments, and is kinetically first order; the rate constant has a remarkable temperature dependence. (3) As the temperature falls, the recovery becomes faster. (4) A much faster recovery occurs in the presence of dithionite. In frozen samples, the recovery with dithionite follows the Arrhenius equation between 35° and 110°K. M.G.J.

N67-31754# Cincinnati Univ., Ohio. Charles F. Kettering Research Lab.

PROPERTIES OF SUBCHLOROPLAST PARTICLES PREPARED BY THE ACTION OF DIGITONIN, TRITON X-100, AND SONICATION

Leo P. Vernon, Bacon Ke, Sakae Katoh, Anthony San Pietro, and Elwood R. Shaw *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 102–114 refs (See N67-31745 18-04)

Data are correlated on the results obtained by treating chloroplasts with digitonin and Triton X-100 detergents, and by sonication. The photochemical activities, pigment compositions, and physical properties of subchloroplast particles produced by these treatments are described. Among the findings reported are: (1) Similar characteristics are found in both the light and heavy particles produced by detergent action. (2) Sonication produces a small particle which is not different in composition from the original chloroplast lamellae. These small particles possess, to a lesser extent, the physical and photochemical properties of the light particles produced through detergent action. M.G.J.

N67-31755# Pennsylvania Univ., Philadelphia. Johnson Research Foundation.

EARLY CHEMICAL EVENTS IN PHOTOSYNTHESIS: KINETICS OF OXIDATION OF CYTOCHROMES OF TYPES *c* OR *f* IN CELLS, CHLOROPLASTS, AND CHROMATOPHORES

B. Chance, D. De Vault, W. W. Hildreth, W. W. Parson, and M. Nishimura *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 115–131 refs (See N67-31745 18-04)

Criteria are established for identifying the first chemical step in photosynthesis. It is pointed out that this step should be a reaction of a protein of known chemical composition, and the reaction should be recognizable on the basis of *in vitro* studies. Consideration is given to the structure, reactivity, and electron transfer times for cytochrome *c*. Summary data on oxidation times are presented to demonstrate that cytochromes of types *c* and *f* can have an extremely short electron leaving time under appropriate conditions; and to emphasize the range of values in a variety of materials, either intact or derived from the cells. Laser flash studies of electron transfer from cytochromes to chlorophyll reveal three categories of reaction mechanisms: (1) a temperature independent process with a time constant of 2 msec: (2) faster reactions of cytochrome with chlorophyll requiring thermal agitation energies; and (3) the possibility of secondary electron transfer reactions involving collisions of the component under observation with a prior electron carrier. M.G.J.

N67-31756# Pennsylvania Univ., Philadelphia. Johnson Research Foundation.

OXIDATION-REDUCTION REACTIONS OF CYTOCHROMES IN RED ALGAE

Mitsuo Nishimura *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 132–142 refs (See N67-31745 18-04)

Light-induced oxidation-reduction reactions of cytochromes have been studied in the living thalli, cells, and isolated plastids of four species of red algae: *Porphyra yezoensis, P. tenera, P. suborbiculata,* and *Porphyridium cruentum.* The role of the two photochemical systems in the cytochrome reactions was examined. A group of substances was investigated which block the reduction of cytochrome-553 by photochemical system II but do not affect the oxidation by photochemical system I or the dark reduction of the cytochrome. Effects of other inhibitors of photosynthesis were analyzed. The values of quantum efficiency and the action spectra of the cytochrome reactions were obtained. Data indicating the possible participation of a *b*-type cytochrome were obtained in the experiments with *m*-Cl-CCP or *p*-CF_3O-CCP. From the effects of many inhibitors and physical conditions on different steps of electron transfer, a scheme for the electron transfer in these organisms was constructed. A laser technique proved effective in analyzing the time sequence of rapid reactions. Comparisons are given between the data obtained with low intensity continuous illumination and with a Q-switched laser. Rapidly reacting cytochrome-553 was the major component in the cytochrome reaction. Author

N67-31757# Harvard Univ., Cambridge, Mass. Biological Labs.

LIGHT-INDUCED ABSORBANCE CHANGES IN WILD-TYPE AND MUTANT STRAINS OF CHLAMYDOMONAS REINHARDI

R. P. Levine, Donald S. Gorman, Mordhay Avron (Weizmann Inst. for Sci., Rehovoth, Israel), and Warren L. Butler (Calif. Univ., La Jolla) *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 143–148 refs Prepared jointly with Weizmann Inst. of Sci. and Calif. Univ., La Jolla (See N67-31745 18-04)

Light-induced absorbance changes exhibited by chloroplast fragments of windtype *Chlamydomonas reinhardi* and certain mutant strains having impaired photosynthesis have been investigated by the technique of double-beam spectrophotometry. The photosynthetic electron transport chain is blocked in each of the mutant strains, for whole cells cannot fix carbon dioxide by photosynthesis, and chloroplast fragments cannot photoreduce NADP when the source of electrons is water. It can be assumed that the block in a given mutant strain has resulted in an inability to synthesize, at least in active form, some essential component of the photosynthetic electron transport chain. Some results of the initial experiments are reported. These experiments suggest that two components, one having an absorbance maximum at 553 mμ and the other at 559 mμ, act in series in the photosynthetic electron transport chain of *C. reinhardi,* and that their oxidation and reduction is coupled via a third component. Author

N67-31758# Weizmann Inst. of Science, Rehovoth (Israel). Biochemistry Section.

RELATION OF PHOSPHORYLATION TO ELECTRON TRANSPORT IN ISOLATED CHLOROPLASTS

Mordhay Avron and Britton Chance (Penn. Univ.) *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 149–159 refs (See N67-31745 18-04)

Investigations were conducted with the aim of obtaining information about the role of the known electron transport components of chloroplasts in the electron transport chain and about the position of the site of ATP formation in relation to these components. Chloroplasts were isolated from spinach leaves, and experiments were performed in the dual-wavelength spectrophotometer. The instrument was slightly modified to allow for continuous stirring of the sample and illumination of the cuvette through interference filters. Two interference filters were routinely used. To activate predominantly system I, a wide-band interference filter (30-mμ half-band width) peaking at 730 mμ was used. To provide light that would be absorbed to a similar extent by the two photosystems, a 640-mμ wide-band interference filter was used (30-mμ half-band width). The intensity of each of these was about 1×10^4 erg/cm^2/sec. Author

N67-31759# Technische Univ., Berlin (West Germany). Max-Volmer-Institut fuer Physikalische Chemie.

ELECTRON TRANSPORT IN PHOTOSYNTHESIS

H. T. Witt, G. Doring, B. Rumberg, P. Schmidt-Mende, U. Siggel *et al* *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 161–168 refs (See N67-31745 18-04)

The periodic flash technique was used on *Chlorella* cells to measure the difference spectrum in the ultraviolet region. Two peaks are observable at 252 and 262 mμ. Each peak probably indicates a different reaction, with the changes around 252 mμ attributed to fully reduced plastoquinone A. Also considered are absorption changes at 703 and 250 mμ in illuminated spinach chloroplasts as a function of light intensity, and the ratio of the concentrations of plastoquinone A and chlorophyll a_1 are calculated. Change of absorption at 254 mμ as a function of time is plotted. Data are presented to confirm that photosynthetic electron transport is practically unaffected when phosphorylation is blocked by desaspidin. It is also shown that intermediate reactions of phosphorylation are linked directly to absorption changes of a pigment. The isolated difference spectrum for *Chlorella* which shows the absorption change at 513 mμ is compared with the difference spectrum for a chlorophyll *b* reaction in pyridine. The similarity in spectra suggests that perhaps H^+ dissociation of Chl-*b* takes place also *in vivo*. M.G.J.

N67-31760# Michigan State Univ., East Lansing. Dept. of Botany and Plant Pathology.

INHIBITION AND UNCOUPLING OF PHOTOPHOSPHORYLATION IN CHLOROPLASTS

S. Izawa, T. N. Connolly, and G. D. Winget *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 169–187 refs (See N67-31745 18-04)
(Grants NSF-GB-841; NSF-GB-4568)

Photophosphorylation inhibition by phlorizin is assessed in relation to the effect of phlorizin on rates of ferricyanide reduction and adenosine triphosphate (ATP) formation in illuminated chloroplasts, and the kinetics of phlorizin inhibition of ATP formation with limiting adenosine diphosphate (ADP) and limiting light intensities, and with limiting phosphate. Also examined in the inhibition of electron transport and photophosphorylation by antimycin A, HOQNO (2-n-heptyl-4-hydroxyquinoline-N-oxide), and DCMU (3-(3,4-dichlorophenyl)-1, 1-dimethylurea). The effects of each on aerobic PMS-catalyzed cyclic photophosphorylation and noncyclic photophosphorylation are compared. Results show that at low light intensities PMS-mediated cyclic electron flow can bypass the sites sensitive to DCMU and HOQNO but not the site of antimycin A action. A mechanism of oxidation of exogenous electron donors by illuminated chloroplasts is proposed: the electron transport, measured by oxygen uptake, is dependent on an autoxidizable electron acceptor and the predicted amount of hydrogen peroxide is formed. The point of entry of electrons into the transport chain seems to depend on the electron donor used. A hypothesis on the nature of uncoupling in chloroplasts is suggested. M.G.J.

N67-31761# Brookhaven Natl. Lab., Upton, N. Y. Biology Dept.

LIGHT INDUCED CHANGES IN CYTOCHROME b_6 IN SPINACH CHLOROPLASTS

Geoffrey Hind and John M. Olson *In its* Energy Conversion by the Photosynthetic App. Jan. 1967 p 189–194 (See N67-31745 18-04)

Data are presented on the steady state difference spectra observed in the cytochrome α-band region upon repeated illumination with either 670- or 705-mμ light. It is pointed out that the trough at 555 mμ corresponds with oxidation of cytochrome *f*; no trough is seen with repeated 705 mμ illumination because the first period of the light oxidizes the cytochrome and its subsequent dark reduction is not possible as the system II electron acceptor pool is empty. In contrast, the reduction of cytochrome b_6 is driven by both red and far-red light and exhibits similar kinetics for on and off responses in both cases. Corresponding cytochrome responses in the γ-band region were also studied. Experiments were conducted to determine the influence of electron transport inhibitors on the α-band changes of the cytochromes, and the associated effects on coupled phosphorylation. The actinic light was centered at 670 mμ. Comparative data on the effects observed are presented, and a scheme is proposed to account for observed inhibitor effects, and to show how cytochromes may operate in electron transport. M.G.J.

N67-31762# Milan Univ. (Italy). Istituto di Scienze Botaniche.

STUDIES ON NADPH-CYTOCHROME *f* REDUCTASE OF CHLOROPLASTS

Giorgio Forti *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 195–201 refs (See N67-31745 18-04)

The properties of the flavoprotein enzyme are described as a basis for understanding the role of the NADPH-cytochrome *f* reductase in photosynthesis. The method for purifying the spinach chloroplast flavoprotein is summarized, and the fluorescence spectrum of the enzyme is depicted to show the emission spectrum of the native enzyme upon excitation with 295- and 276-mμ light. Inactivation of the diaphorase by NADPH as a function of enzyme concentration is discussed. The data show: (1) Inactivation is observed at low concentration of the enzyme and decreases as concentration increases. (2) Rapid inactivation occurs in a few minutes of incubation with NADPH, but the surviving activity is stable for several hours. (3) The NADP prevents and reverses completely the inactivation by NADPH when present at the same concentration. (4) In the presence of a relatively low concentration of urea, inactivation by NADPH becomes complete and irreversible, and can be delayed but not prevented by NADP. A working hypothesis is suggested to explain the inactivation mechanism of the enzyme and some features of its active site. M.G.J.

N67-31763# Public Health Research Inst., New York. Dept. of Biochemistry.

EFFECT OF A COUPLING FACTOR AND ITS ANTISERUM ON PHOTOPHOSPHORYLATION AND HYDROGEN ION TRANSPORT

Richard E. Mc Carty and Efraim Racker *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 202–213 refs (See N67-31745 18-04)
(Grant PHS-CA-03463-09)

Data are presented on the participation of a coupling factor in photophosphorylation and related processes, and on its role in the light-induced *p*H rise and the ATP synthesis which accompanies an acid to base transition of chloroplasts in the dark. Further evidence is provided on the participation of a latent, Ca^{++} dependent ATPase protein from chloroplasts in photophosphorylation. The antiserum inhibited the light dependent reactions involving the nucleotides, whereas the light-induced *p*H rise and optical density changes occurring in the absence of added nucleotides were unaffected. Light-induced H^+ uptake is thought to be dependent on a nonphosphorylated high energy intermediate, or the *p*H

gradient formed by electron transport may represent a high energy state of the chloroplast. It is concluded that the coupling factor does not participate in the formation of the high energy intermediate or state in chloroplasts; rather, it is probably acting at the terminal end of the phosphorylation mechanism. M.G.J.

N67-31764# Johns Hopkins Univ., Baltimore, Md. McCollum–Pratt Inst.
PHOTOPHOSPHORYLATION AND THE CHEMI-OSMOTIC HYPOTHESIS
A. T. Jagendorf and E. Uribe *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 215–245 refs (See N67-31745 18-04)

Consideration is given to a chemi-osmotic hypothesis, in which the process of directional transport of hydrogen ions across the topologically complete phosphorylating membrane, from the outside medium to an enclosed inner space, provides the crucial link between electron transport and phosphorylation. The application of this hypothesis to chloroplasts is assessed in relation to several experimental results. These include studies of post-illumination ATP synthesis, light-induced *p*H rise, acid-base transition in the dark, energetics and stoichiometry, the relative rates of photophosphorylation and of X_E accumulation at *p*H 7, and bicarbonate stimulation of photophosphorylation and inhibition of X_E. It is felt that the overall combination of results obtained is easier to explain by the chemi-osmotic assumptions than by any other single theory; however, it is pointed out that there is not sufficient justification for accepting the hypothesis as the proven mechanism for photophosphorylation. M.G.J.

N67-31765# Stockholm Univ. (Sweden). Wrenner-Gren Inst.
LIGHT-INDUCED ENERGY CONVERSION AND THE INORGANIC PYROPHOSPHATASE REACTION IN CHROMATOPHORES FROM RHODOSPIRILLUM RUBRUM
Margareta Baltscheffsky, Herrick Baltscheffsky, and Lars-Victor von Stedingk *In* Brookhaven Nat. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 246–257 refs (See N67-31745 18-04)

Summary data are presented on the bacterial photophosphorylation system in chromatophores at two consecutive intermediate stages of energy conversion between electron transport and phosphorylation at the nucleotide level. These stages are a light-induced *p*H change, and a light-induced formation of inorganic pyrophosphate. The pyrophosphatase reaction in bacterial chromatophores is discussed in relation to findings which indicate: (1) The hydrolysis of inorganic pyrophosphate in chromatophores represents a reversal of the final reactions in photophosphorylation of inorganic orthophosphate to inorganic pyrophosphate. (2) The intermediate $X \approx P$ of various electron transport phosphorylation systems could be a common final intermediate for the formation of both ATP and inorganic pyrophosphate. M.G.J.

N67-31766# Cincinnati Univ., Ohio. Charles F. Kettering Research Lab.
ION AND WATER TRANSPORT PROCESSES IN SPINACH CHLOROPLASTS
Richard A. Dilley *In* Brookhaven Natl. Lab. of Energy Conversion by the Photosynthetic App. Jan. 1967 p 258–279 refs (See N67-31745 18-04)

The physical properties of chloroplast were studied as a basis for testing a proposed model for light-induced shrinkage. Some of the osmotic properties of the chloroplast outer membrane and thylakoid membrane are characterized, and Donnan-type ion distributions which occur in plastids under different conditions are described. The light-induced shrinkage is compared with shrinkage induced by osmotic pressure and *p*H changes. The light-induced H^+ pump and photophosphorylation are examined in relation to their inhibition by various uncouplers of photophosphorylation and the effect of light intensity on the mode of inhibition. The action spectrum of the H^+ pump is measured and compared with that of cytochrome *c* photoreduction, and the apparent relationship of the H^+ phenomena observed in experiments on the chemi-osmotic theory of energy coupling is discussed. A conceptualized model of the spinach chloroplast in regard to compartmentation and permeability of membranes to various solutes is depicted. M.G.J.

N67-31767# California Univ., Berkeley. Dept. of Physiology.
CONFORMATIONAL CHANGES IN CHLOROPLASTS
Lester Packer, David W. Deamer, and Antony R. Crofts *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 281–302 refs (See N67-31767 18-04)

A unified concept is presented on the mechanism by which light and the energy conversion process function in the control of conformational changes in spinach chloroplasts and their grana membrane system, and in the intact living leaf cell. Experimental results are given to support the following views: (1) Chloroplasts suspended in sodium chloride solutions undergo structural modifications when illuminated by red actinic light in the presence of electron carriers. These changes are manifested by increments in light scattering and volume, and by disruptive alterations of grana structure as demonstrated by electron micrography. (2) Simultaneously with these modifications, protons are transported into the chloroplasts in a light-dependent process. The decrease in internal *p*H which results from the proton transport causes many of the changes observed in chloroplasts during illumination. (3) On acidification of the chloroplast interior by light-induced hydrogen ion uptake, weakly acidic anions are lost due to displacement of the equilibrium of undissociated acid across the chloroplast membrane, and the volume changes observed occur by osmotic equilibration. M.G.J.

N67-31768# California Univ., Berkeley. Dept. of Chemistry.
CHLOROPHYLL–CHLOROPHYLL INTERACTIONS
Edward A. Dratz, Alfred J. Schultz, and Kenneth Sauer *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 303–318 refs (See N67-31745 18-04)

Measurements were made on the circular dichroism (CD) and absorption spectra of dimers of chlorophylls *a* and *b* and bacteriochlorophyll in carbon tetrachloride solution, and of suspended crystalline chlorophyll *a*. Preliminary analyses indicate: (1) All dimers are similar in structure, and the chlorophyll–chlorophyll interactions result in very large optical activity relative to that of the monomer. (2) The molecular planes are not parallel or coplanar in the dimer, nor are the transition moments parallel. Data on CD and absorption spectra of photosynthetic particles are also presented. The CD measurements give strong evidence for chlorophyll-chlorophyll interaction. It was concluded that some of the chlorophyll *a* absorbing on the long-wavelength side of the main quantasome absorption band is aggregated; chlorophyll *b* shows evidence of interactions with other chlorophyll *b* in the quantasome. M.G.J.

N67-31769# Cincinnati Univ., Ohio. Charles F. Kettering Research Lab.
EVIDENCE FOR THE PRESENCE OF ORDERED AGGREGATES IN CHLOROPHYLL *a* MONOLAYERS
Bacon Ke and Walter Sperling *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 319–327 refs (See N67-31745 18-04)

To simulate chlorophyll arrangements resembling those in the natural state, model systems were prepared by constructing chlorophyll monolayers and multilayers. Measurements were made under ambient conditions to determine the absorption and change in absorption, and the optical rotation (OR) of chlorophyll *a* monolayers. Based on the experimental data obtained, it is suggested: (1) Chlorophyll *a* molecules in the monolayers obtained by the deposition technique exist in different states. Evidence for different chlorophyll forms is provided mainly by the temporal difference

spectra, with maxima located on the longer-wavelength side of the regular chlorophyll absorption bands. (2) By applying different surface pressures during the deposition of the monolayers, red difference bands with maxima ranging from 685 to 712 mμ could be obtained. It is assumed that these long-wavelength absorbing forms are aggregates. (3) Absorption measurements with polarized light showed that the chlorophyll layers exhibited dichroism. (4) The wavelength position of the initial OR maximum in the red region is dependent on the surface pressure applied during preparation.
M.G.J.

N67-31770# Cologne Univ. (West Germany). Botany Inst.
THE MOLECULAR STRUCTURE OF PHOTOSYNTHETIC LAMELLAR SYSTEMS
Wilhelm Menke *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 328–340 refs (See N67-31745 18-04)

Several models on the molecular and submolecular structure of thylakoids of purple bacteria, and of those derived from chloroplasts are examined. These include two models of a protein layer with a less dense middle zone, models of a vesicle-like and a flattened bacterial thylakoid with the protein layer on the outside, and an older model of a chloroplast thylakoid in which the protein layer probably has a less dense middle zone. The results obtained by various methods are assessed in an effort to form a more precise concept of the protein layer structure. Indications are that the thylakoids of bacteria have an outer boundary layer which consists mainly of proteins, and that the major portion of the lipids is localized within the thylakoid. It is likely that there is molecular interaction between the proteins and the lipids. Previous studies show that thylakoids derived from bacteria and chloroplasts are formed on the same principle of molecular structure; it is pointed out, however, that there are surely differences between the two which must be delineated.
M.G.J.

N67-31771# California Univ., Berkeley. Dept. of Botany.
FREEZE ETCHING OF CHLOROPLASTS FROM GLUTARALDEHYDE-FIXED LEAVES
Roderic B. Park and Daniel Branton *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 341–352 refs (See N67-31745 18-04)

The different interpretations drawn from studies on chloroplast morphology by the freeze-etching technique are discussed, and data pertinent to the disagreements are presented. The most interesting data from freeze-etching are considered to be the breaks parallel to the thylakoid rather than the chloroplast cross sections; the membranes provide planes of natural weakness in the frozen chloroplasts, and breaks often proceed along membrane faces. It was concluded: (1) Freeze-etching supports the view that the thylakoid is an example of a micellar membrane in which 175×90 Å and 100×90 Å particles are embedded in the membrane matrix. (2) The 175 Å particles are confined to membranes which contain chlorophyll or bacteriochlorophyll, which appear to represent a quantum conversion and electron transport, and correspond to the quantasome in shadowed preparations. (3) Membrane surfaces are dependent on the presence of lipid in the membrane. Removal of the lipid eliminates the weak face along which breaks occur, which suggests that the membrane faces are nonpolar in nature.
M.G.J.

N67-31772# California Univ., Davis. Dept. of Botany.
THE PHOTOSYNTHETIC APPARATUS IN CHLOROPLASTS OF HIGHER PLANTS
T. E. Weier, C. R. Stocking, and L. K. Shumway *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 353–374 refs (See N67-31745 18-04)
(Grants NSF GB-2319; NSF GB-2546)

Electron microscope studies are discussed in which it was shown that the chloroplast membranes are characterized by a membrane structure composed of arrays of parallel membranes alternating with electron-transparent hydrophilic areas. The end granal membrane is composed of a single row of subunits and the partitions are composed of two rows of subunits. The grana are connected at irregular intervals by a system of membrane-bounded channels called frets. In the interpretation of the membrane structure given, the photoreaction involving chlorophyll takes place in living cells within the partition. A three-dimensional view is presented on the concept of the membrane systems of a chloroplast, and a diagram is included to show the relationships between membranes and stroma in overall photosynthetic reactions. The carbon cycle is located in the stroma, and light reactions occur in the grana, most probably in the partitions. Energy must be transferred from the partitions to participate in the carbon cycle in the stroma.
M.G.J.

N67-31773# Temple Univ., Philadelphia, Pa. Dept. of Biology.
THE ISOLATION OF NONGRANULAR CHLOROPLASTS FROM HIGHER PLANTS
Thomas Punnett *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 375–379 refs (See N67-31748 18-04)

Details are given on the procedures used to improve the medium that allows the isolation of nongranular chloroplasts. These involved altering the medium so that lower concentrations of Carbowax could be used without reducing the proportion of nongranular chloroplasts. All preparations were done routinely at room temperatures. Tabulated data are given on the composition in which the concentration was reduced from 27% to 6%, resulting in low viscosity and no appreciable clumping of the chloroplasts due to precipitation of protein on and around them. As conventional electron micrograph fixation procedures were found to induce granularity in isolated chloroplasts, a procedure was developed that does not visibly change their appearance. This is based on the use of a 4% to 8% concentration of glutaraldehyde in the Carbowax medium used as fixative.
M.G.J.

N67-31774# Florida State Univ., Tallahassee. Inst. of Molecular Physics.
CHLOROPLAST STRUCTURE AND THE PHOTOSYNTHETIC UNIT
Georg Schmid and Hans Gaffron *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 380–392 refs (See N67-31745 18-04)
(Contract AT(40-1)-2687)

Correlations between unusual chloroplast structure and unusual chlorophyll function are described. An electron micrograph is shown of chloroplast from a healthy tobacco plant which has only 1/8 to 1/10 of the normal chlorophyll content; this deficiency is reflected in the appearance of straight, widely separated lamellae and hardly any grana. The unusual function which accompanies the unusual structure is demonstrated by comparing the light saturation curve of photosynthesis for a given area of dark green normal leaf with that of the same area of a chlorophyll-deficient leaf. It is pointed out that not only does high light compensate for lack of chlorophyll, but that on an absolute scale of carbon dioxide fixed per square centimeter such a leaf can have a greater capacity for photosynthesis than the dark green ones. Normal and chlorophyll-deficient rates per mg chlorophyll are plotted. Pigment content and its changes with increasing chlorophyll deficiency are analyzed. It is speculated that the highly respiring mutant may have a good supply of ribulose diphosphate or another carboxylation aid such as ATP, while the normal plant must first accumulate it.
M.G.J.

N67-31775# Dartmouth Coll., Hanover, N. H. Dept. of Microbiology.
PHYCOBILIPROTEIN LOCALIZATION IN ALGAE

E. Gantt and S. F. Conti *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 393–405 refs (See N67-31745 18-04)

To determine possible locations for the phycobiliproteins, experiments were conducted on the unicellular red alga *Porphyridium cruentum*. The data resulting are presented in support of the argument that the phycobiliproteins are located in the lamellae; this is based on the assumption that, in order for the phycobiliproteins to transfer their energy effectively to chlorophyll, both the phycobiliproteins and the chlorophyll must be in the lamellae. It is pointed out that the phycobiliproteins are attached to the lamellae in the form of granules; since the granules are attached to the lamellae, they are within the 50 Å distance considered necessary for effective energy transfer. Other reasons for considering these chloroplast granules of *P. cruentum* as sites of phycobilin aggregation are: (1) When the red color disappears from chloroplast fragments, the granules also disappear from the lamellae. (2) When chlorophyll is removed by methanol–acetone extraction, the stainable membrane components are removed, but the purple–pink color and the granules both remain. M.G.J.

N67-31776# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.

STUDIES ON THE FUNCTION OF MANGANESE IN PHOTOSYNTHESIS

G. M. Cheniae and I. F. Martin *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 406–417 refs (See N67-31745 18-04)

(Contract NASw-747)

The alga *Scenedesmus* D_3 was used both for whole cell studies and as a source of chloroplasts in experiments conducted to critically evaluate the function of manganese in photosynthesis. Among the results reported are: (1) The effects of manganese deficiency is dependent upon the level of deficiency. (2) The concept that the effect of Mn deficiency is primarily upon photosystem II is supported by data from relative quantum yield measurements with Mn-deficient or normal particles on reactions sensitized by photosystem I. (3) Chloroplast particles obtained from uniformly Mn^{54}-labeled cells bind the incorporated manganese tenaciously. By several procedures, however, it is possible to remove all manganese from the particle without loss of photosystem I activity. (4) There seems to be no direct correlation between loss of Mn and loss of Hill activity as judged by the dissimilarity in their kinetics. (5) Several hypotheses concerning the manner in which manganese is bound within the chloroplasts are discussed briefly. M.G.J.

N67-31777# Institut de Biologie Physico-Chimique, Paris (France).

OXYGEN EVALUATION IN ALGAE ILLUMINATED BY MODULATED LIGHT

P. Joliot *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 418–433 refs (See N67-31745 18-04)

Operating principles of an amperometric apparatus are described, and the use of this technique in two different types of applications is discussed. In one, the photosynthetic production of oxygen can be followed. The amplitude of modulated signal is proportional to the sinusoidal variation of oxygen production, which is proportional to the average rate of oxygen production. Under normal conditions, the response time is about 10 times the period of modulation. At low frequencies, the sensitivity is very high; an average oxygen production of about 10^{-16} moles O_2/sec can be measured with precision. In this case the incident light intensity is about 10^{-1} erg/sec/cm^2. Examples are given on its use in studies of induction phenomena, chromatic effects, and activation periods. The second application concerns limiting processes occurring between the photochemical act (system II) and the reduction of oxygen at the electrode. Examples show its use in determining oxygen diffusion from algae to electrode, phase delay due to algae, intensity of modulated signal, and limiting intracellular processes. M.G.J.

N67-31778# Illinois Univ., Urbana. Dept. of Botany.

FLUORESCENCE STUDIES WITH ALGAE: CHANGES WITH TIME AND PREILLUMINATION

John C. Munday Govindjee, Jr. and George Papageorgiou *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 434–445 refs (See N67-31745 18-04)

An assessment is made of certain aspects of the fluorescence induction phenomenon in the millisecond-to-second range, and the slower changes in fluorescence up to one or two hours. Findings show: (1) Preillumination with far-red light causes a strong decrease of the P peak and an increase in the S level in *Chlorella*; after a subsequent dark period, the P level is higher than before. (2) Normal and DCMU-poisoned *Anacystis nidulans* cells show first an increase followed by a decrease of fluorescence with time when both the preilluminating light and the excitation light are orange (590 mμ). Poison cells show changes 2 to 4 times larger. (3) Preillumination modifies the emission spectrum, and the direction of changes depends on the quality of the light to which the cells are exposed. Spectra changes occur around 685 mμ (the usual peak) and around 695 mμ. (4) An alternative model of photosynthesis is proposed in which the sole purpose of light reaction is the production of a high energy intermediate which is not a reductant. M.G.J.

N67-31779# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.

OBSERVATIONS ON THE REDUCING SIDE OF THE O_2 EVOLVING PHOTOACT

Bessel Kok, Shmuel Malkin, Olga Owens, and Biff Forbush *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 446–459 refs (See N67-31745 18-04)

Experiments to determine fluorescence rise curves are described, and the results obtained are plotted. Two schemes to explain such curves are discussed. In one, it is assumed that the small pool E is at the oxidizing side of photoact II; the number of traps Q is large, in fact equal to the number of A molecules; and separate and linear chains in which cross-transfer of photons between pigment units, and of electrons between the Qs and As of different units are forbidden. This model describes the long induction in detail. The second scheme assumes that the pigment complex of system II has the same size as that of system I, the concentration of quencher Q being the small pool of 1–500 Chl while A accounts for nearly all of the large pool (Q+A). This simpler model describes the short induction. Within the framework of this simpler scheme, consideration is given to the normal potentials of Q and A computed from the fluorescence yield, residual photoprocesses, the kinetics of DPIP reduction and oxidation, and the site of photophosphorylation. M.G.J.

N67-31780# Cincinnati Univ., Ohio. Charles F. Kettering Research Lab.

CHEMILUMINESCENCE OF CHLOROPLASTS

Berger C. Mayne *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 460–466 refs (See N67-31745 18-04)

Data are presented to show that the luminescence of chloroplasts produced by acid-base transition, with a spectrum similar to that of the fluorescence of chlorophyll *in vivo*, was inhibited by DCMU, uncouplers of phosphorylation, cofactors of phosphorylation, and ferricyanide. The Dio-9 reversed the inhibition of luminescence produced by cofactors of phosphorylation. Hydrosulfite reduction also caused light emission from chloroplasts. A formal scheme was presented linking ATP formation and luminescence. Author

N67-31781# Florida State Univ., Tallahassee. Inst. of Molecular Biophysics.
CHLOROPHYLL-INDEPENDENT PHOTOCHEMISTRY IN ALGAE
Wolfgang Kowallik *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 467–477 refs (See N67-31745 18-04)
(Grant NGR-10-004-018)

Discussion centers on a metabolic photochemistry in algae which does not depend on chlorophyll or on the structures typical for the photosynthetic apparatus. The observations described are an enhancement of respiration by blue light ($\lambda < 550$ mμ) in a chlorophyll-free yellow *Chlorella* mutant. Comparative data show the oxygen uptake in the mutant in darkness and in blue light over a 41-hour period. The findings indicate that after almost two days in blue light the respiration rate is above that of the dark control which shows the normal decline of the rate with time. When the blue light is turned off, the rate of the enhanced respiration immediately begins to decline, but just as slowly as the normal dark respiration does. A small but measurable effect of blue light on respiration persists even after one hour in darkness. Four color bands were isolated in an attempt to find the effective spectral region. The effect of blue light was 2 to 3 times as great as that of green light; no effect was noted in red light, and only a trace in the orange region. M.G.J.

N67-31782# Zürich Univ. (Switzerland). Dept. of General Botany.
PHOTOOXIDATION OF MANGANESE BY CHLOROPLASTS
Reinhard Bachofen *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 478–484 refs (See N67-31745 18-04)

Experimental results obtained with isolated chloroplasts are presented to demonstrate a direct oxidation of added manganese by a reaction with some unknown electron carrier of the electron transport chain located between water and pigment complex II. It is concluded that the oxidation of manganese by illuminated chloroplasts is a direct reaction of Mn^{+2} with an electron carrier located between water and pigment complex II. Detergents separate these electron carriers together with the pigment complex from the oxygen-evolving enzymes. The DCMU acts at the same site in blocking the electron flow mainly between water and the electron carriers which react with external manganese. M.G.J.

N67-31783# Hull Univ. (England). Dept. of Botany.
THE OXIDATION OF UNSATURATED LIPIDS BY ISOLATED SUGAR BEET CHLOROPLASTS
J. Friend and G. J. Acton *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 485–490 refs (See N67-31745 18-04)

A reassessment is made of the role of lipids in crocin oxidation both by deoxycholate extracts of sugar beet chloroplasts and by the chloroplasts themselves at *p*H 7.6. The data indicate that such crocin oxidation is closely linked with the oxidation of unsaturated lipids. Lipoxygenase and hematins catalyze carotenoid oxidation in the presence of unperoxidized and partially peroxidized linoleate respectively. Neither system appears involved in either the crocin or lipid oxidation. Lipoxygenases are not inhibited by cyanide, and EDTA does not inhibit crocin oxidation by lipoxygenase in the presence of linoleate. Hematin catalysts show optimal activity both for linoleate oxidation and for crocin oxidation in the presence of linoleate between *p*H 3.5 and 4.5; they are not inhibited by EDTA. It was found that the oxidation of crocin and linoleate by a synthetic system consisting of copper sulfate, serum albumin, and linoleate is active above *p*H 7 and is inhibited by KCN and EDTA. Author

N67-31784# Johns Hopkins Univ., Baltimore, Md. McCollum-Pratt Inst.
LABILE $C^{14}O_2$ FIXATION PRODUCTS BY CHLOROPLASTS AND THEIR POSSIBLE RELATION TO THE MECHANISM OF PHOTOSYNTHESIS
Shigetoh Miyachi *In* Brookhaven Natl. Lab. Energy Conversion by the Photosynthetic App. Jan. 1967 p 491–514 refs (See N67-31745 18-04)
(Grant NSF GM-03923)

Data are presented on $C^{14}O_2$ fixation experiments, in which *Chlorella* cells which had been incubated in 20% $C^{14}O_2$ in air were treated with diazomethane. Significant amounts of stable C^{14} compounds were obtained, indicating the existence of labile $C^{14}O_2$ fixation products; the compounds could be separated by two-dimensional paper chromatography. It is pointed out that if some compounds function in the mechanism of O_2 evolution, they should also be found when chloroplast particles are used. Formation of these products in isolated chloroplasts, as well as the behavior of the compounds under different conditions, is described briefly. The amount of stabilized $C^{14}O_2$ from the chloroplasts was found to be far smaller than that reported for photolyte. The observations that oxygen is not required for forming labile C^{14} compounds, and that the addition of fluoric acid does not destroy the compounds in *Chlorella* cells suggest that none of the labile C^{14} compounds is related to photolyte. However, the fact that the ability to form such compounds is not lost by successive washings of chloroplasts is taken to indicate that the factors functioning in their formation are bound to the photosynthetic machinery. M.G.J.

N67-31815*# National Aeronautics and Space Administration, Washington, D. C.
ULTRAWEAK LUMINESCENCE ACCOMPANYING BIOCHEMICAL REACTIONS
Yu. A. Vladimirov Jul. 1967 81 p refs Transl. into ENGLISH of the book "Sverkhslabyye Svecheniya Pri Biokhimicheskiyh Reaktsiya" Moscow, Izd. Nauka, 1966
(NASA-TT-F-456) CFSTI: HC $3.00/MF $0.65 CSCL 06A

A survey is made of research on ultraweak luminescence in biochemical reactions in an attempt to demonstrate that although the reactions leading to the formation of products participating the chemiluminescence reaction are different from system to system, the final stages culminating in the emission of a quantum of electromagnetic radiation have many features in common. The energy of any biochemical reaction is the result of solar energy stored during photosynthesis which is gradually expended during other biochemical process. However, a basic solution to the problem of whether this energy could be released in the form of light quanta became possible only after the development of sensitive and stable photon counters based on photomultipliers with a low dark current, and especially photomultipliers cooled by liquid nitrogen. Research trends noted include increasing studies of biological objects having luminescence, detailed phenomenological studies of luminescence, and increasing emphasis of clarifying the biochemical reaction mechanism which leads to the accumulation of products responsible for luminescence. R.N.A.

N67-31859*# Ohio State Univ. Research Foundation, Columbus. Environmental Medicine Lab.
CARDIOVASCULAR EFFECTS OF VIBRATION Semiannual Report, 1 Aug.–31 Dec. 1966
Lester B. Roberts Jun. 1967 17 p refs
(Grant NGR-36-008-041; Proj. RF-2045)
(NASA-CR-85611; Rept.-3) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Described is the development of equipment for vibrating human subjects at frequencies from 0.5 to 3 Hz. Several ECGs obtained with the equipment show no significant change from normal. In a second study, experiments were conducted to confirm the importance of the electrode placement and the need to employ the

exploring electrode techniques to determine the heart electrical center horizontal plane. Equipment was modified to (1) eliminate the need for grounding the operator; (2) use fixed electrodes; and (3) perform electrode manipulations through a switchbox. Experiments with a dog were continued to study the mechanism of transitory cardiovascular changes associated with vibration. Information necessary to determine heart rate, systemic arterial pressure, cardiac output, and peripheral vascular resistance was obtained in recorded form. Also presented is a list of requirements for a suitable atraumatic measurement of blood pressure of human subjects while they are being vibrated. K.W.

N67-31874*# Hawaii Univ., Honolulu. Pacific Biomedical Research Center.

PHYSIOLOGICAL AND PSYCHOLOGICAL PERFORMANCE OF HIGHLY MOTIVATED SCIENTIFIC PERSONNEL IN A SEVERE ENVIRONMENT

Terence A. Rogers Jun. 1967 67 p

(Grant NGR-12-001-020)

(NASA-CR-86610) CSCL 06S

A study was conducted to evaluate human performance under extreme conditions of a 10-day cross-country journey on foot in the winter arctic. In order to obtain detailed physiological data two groups of highly motivated subjects undertook a journey of about 200 km. The physiological responses of a group fed at the rate of 3800 kcal/day were compared with those of a group receiving only 2000 k/cal/day. In this way objective partial evaluation was made of the feasibility of extending the range of a patrol or exploration party by cutting down the weight of food carried for each day on the trail. Electronic monitoring systems were also evaluated during the journey. Author

N67-31876*# Harvard Univ., Boston, Mass. Thorndike Memorial Lab.

A STUDY OF PHYSIOLOGICAL MECHANISMS AND INTER-RELATIONS BETWEEN SYSTEMIC AND REGIONAL BLOOD VOLUME, BLOOD FLOW AND ELECTROLYTE BALANCE Interim Progress Report

Walter H. Abelmann and Laurence E. Earley 30 Jun. 1967 8 p refs

(Grant NsG-595)

(NASA-CR-86695) CFSTI: HC $3.00/MF $0.65 CSCL 06P

The interrelationship between renal hemodynamics and sodium and water balance in the dog is examined. Measurements were made of the deep intrarenal hydrostatic pressure through wedged renal venous catheters during maneuvers known to affect sodium excretion. Observations supported the suggestion that transmission of pressure into the kidney is a determinant of sodium reabsorption and excretion. Studies were also conducted on the role of atrial size and function in the regulation of sodium excretion. Measurements of systemic and renal hemodynamics were made. Determinants of the circulatory response to upright tilt were investigated. The role of ventricular filling pressures and circulating blood volume in determining increased orthostatic tolerance was further tested by simulation of these aspects of heart failure. In addition, the hemodynamic effects of phosphate supplements in Paget's disease of the bone were considered. Data suggested that oral phosphate supplements favorably affected the abnormal cardiovascular dynamics of Paget's disease and promoted calcium retention in this disorder. S.P.

N67-31878 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.

DETERMINATION OF RADIATION QUALITY BY USE OF THE RECOMBINATION METHODS

M. Zielczynski 1967 14 p refs In RUSSIAN; ENGLISH summary

(INR-786(XXX))

The quality of radiation, considered from the standpoint of its biological influence, is determined by the spatial and time distribution of energy imparted to tissues. One of the main parameters of the microscopic spatial energy distribution is the linear energy transfer (LET). The recombination methods provide the possibility for the measurements of LET value, averaged after a given relation and particularly for the estimation of the quality factor (QF) of mixed radiation having any spectrum and composition. Various recombination methods are based on the use of relations between the ion recombination and magnitude or direction of the electric field strength, gas pressure or time. With the application of the appropriate method it appears possible to determine QF and other parameters, related to LET in various circumstances. Author

N67-31880* Hughes Aircraft Co., Culver City, Calif. Aerospace Group.

SURVEYOR STERILIZATION. PART IV: STUDIES OF STERILIZATION TECHNIQUES

Myra Willard and Alice Alexander Aug. 1962 35 p refs Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-86673; RS-293; Pt. IV) CSCL 06M

Sterilization techniques were studied for three Surveyor items—the thermally controlled compartments, inertial reference unit, and thermal control coating. It was found that: (1) Ethylene oxide–Freon 12 gas would diffuse through and sterilize the 100 layers of aluminized mylar in the thermally controlled compartments. (2) Ethylene oxide–Freon 12 gas would not penetrate sufficiently to sterilize under the tabs securing the gyros in place in the inertial reference unit. (3) Ethylene oxide–Freon 12 gas would not diffuse through thermal control coating sufficiently to sterilize surfaces painted with the coating. (4) 3.7 percent formaldehyde incorporated in thermal coating produced a sterilizing coating formulation. Author

N67-31984# Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR).

THE PROBLEM OF GENERAL RADIATION SENSITIVITY OF ORGANISMS [K VOPROSU OB OBSHCHIKH PROBLEMAKH RADIO-CHUVSTVITEL'NOSTI ORGANIZMA]

P. D. Gorizontov, N. G. Darenskaya, M. P. Domschlak, and A. B. Tsypin 1965 37 p refs In RUSSIAN; ENGLISH summary

(NP-16258)

A detailed survey on overall radiation sensitivity of entire living organisms and its comparison with the sensitivity of individual systems is presented. Separate sections deal with the sensitivity of particular species, the sensitivity differences within an individual species, age-dependent sensitivity, sex-conditioned sensitivity, seasonal sensitivity, and individual sensitivity to radiations. It is concluded on the basis of considerable experimental evidence that one must use distinct approaches during studies of radiation sensitivity and radiation damage and that radiation damage depends in a definite manner on the state of the nervous system, endocrine glands, blood system, the level of exchange processes, and other physiological parameters. NSA

N67-32032# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.

THE TOLERANCE OF CATTLE TO "LONG" DURATION REFLECTED PRESSURES IN A SHOCK TUBE

Edward G. Damon, Charles S. Gaylord, John T. Yelverton, and Donald R. Richmond Aug. 1966 33 p refs

(Contract DA-49-146-XZ-372)

(DASA-1855; AD-653023) CFSTI: HC $3.00/MF $0.65

Twenty-seven steers, mounted side-on against the endplate of an air-driven shock tube, were exposed to sharp-rising reflected pressures of 184-msec duration. Pressure-time measurements were made with piezoelectric pressure transducers. Autopsies were performed on all animals and the nature of their blast injuries

determined. The LD50 reflected pressure, obtained by probit analysis, was 43.1 psi for steers having a mean body weight of 180 kg. The results are compared with tolerance values obtained in previous investigations involving exposure of eight species of smaller animals to overpressures of 400-msec duration. Twenty-four hour, time-lethality data for steers are compared with those of five species of smaller animals. The potential use of blast-injured domestic animals, as a source of food, is briefly discussed. Author (TAB)

N67-32086* Public Health Service, Cincinnati, Ohio. Milk and Food Research.
ECOLOGY AND THERMAL INACTIVATION OF MICROBES IN AND ON INTERPLANETARY SPACE VEHICLE COMPONENTS Quarterly Progress Report, 1 Apr.–30 Jun. 1967
Robert Angelotti Jul. 1967 13 p refs
(NASA Order R-36-015-001)
(NASA-CR-86616; QPR-9) CSCL 06M

Dry heat resistance of spores was determined at controlled water activities. The D_{135} values for *Bacillus subtilis* var. *niger* spores encapsulated in lucite exposed to water activities are reported. Another system employing inoculated stainless steel strips exposed to a water activity demonstrated the protective effect of moisture on dry heat resistance. The thermal resistance of spores on stainless steel was comparable to that of epoxy encapsulated spores. In addition, D values were determined for mated surface units at 150 inch-pounds torque. Projected research is briefly mentioned. S.P.

N67-32103*# Stanford Univ., Calif.
ANALYSIS OF HUMAN KOROTKOV SOUNDS Semiannual Status Report
14 Jul. 1967 24 p ref
(Grant NGR-05-020-180)
(NASA-CR-86609) CSCL 06B

Korotkov sounds were analyzed by development of an automatic incremental blood pressure cuff deflation system. The system proved useful not only in recording data but also in routine patient monitoring. A spectral analysis of Korotkov sounds was made on surgical patients to find changes related to the stress of vasopressor drugs, general anesthesia, and surgical operations. The capability of stethoscopes to transduce Korotkov blood pressure sounds was examined. Studies were also made of the R–K pulse-wave arrival time, which is the interval between the peak of the R-wave and the arrival of the resulting pulse at the brachial artery. S.P.

N67-32105# San Diego State Coll., Calif.
IDENTIFICATION OF THE PROPOSAL: X-RAY INDUCED CHANGES IN DROSOPHILA GERM CELLS Progress Report, 1 Sep. 1965–31 Aug. 1966
Robert R. Rinehart 31 Aug. 1966 18 p refs
(Contract AT(04-3)-590)
(SAN-590-1) CFSTI: HC $3.00/MF $0.65

Progress is reported in studies on the effects of X radiation on germ cells in Drosophila, with emphasis on metabolic and physiological influences on mutation processes. Results are included from studies of mutations from Drosophila males and females cultured on food exposed to 150, 500, or 3000 kR X radiation; measurements of frequencies of detached and attached X-chromosomes from females given helium treatments; the effects of helium treatments on spermatogenesis; and detachments in eggs from irradiated single females. NSA

N67-32117* Maryland Univ., College Park. Dept. of Psychology.
A COMPARISON OF FIXED RATIO AND VARIABLE RATIO PUNISHMENT WITH AND WITHOUT A WARNING SIGNAL
David Orme-Johnson [1967] 27 p refs
(Grant NsG-189-61)
(NASA-CR-86578; TR-67-13) CSCL 05J

Variable ratio and fixed ratio punishment of variable interval responding were compared on a multiple schedule. VR 10 punishment produced a greater punishment effect than FR 10 punishment. Two possible explanations for this effect were proposed. The first explanation stresses S's being able to discriminate which response will be punished. Potentially, on FR 10 punishment S can discriminate that the 10th response will be punished while on VR 10 punishment there is no way to make such a discrimination. The second explanation stresses the discrimination of the frequency of punishers during a session on the VR vs. the FR schedule. Possibly, S's "average" differently the rate of shocks received on variable and fixed schedules. To test the first explanation, a "warning signal" for punishment was programmed to occur when the next response would be punished, making when punishment would occur easily and equally discriminable on the two schedules. If the first explanation were true, one would expect the VR–FR difference to diminish when the "warning signal" was programmed. It was found however that with the "warning signal" VR punishment continued to produce a greater punishment effect than FR punishment and the second explanation was supported. Author

N67-32248*# George Washington Univ., Washington, D. C.
[BIOLOGICAL SCIENCES COMMUNICATION PROJECT] Quarterly Report, Apr. 1–Jun. 30, 1967
C. W. Shilling 30 Jun. 1967 327 p refs
(Contract NSR-09-010-027)
(NASA-CR-86650) CSCL 06F

CONTENTS:

1. BIBLIOGRAPHY ON APPLICATIONS OF ETHYLENE OXIDE D. E. Wright and A. K. Sarrell 33 p refs (See N67-32248 18-04)

2. BIBLIOGRAPHY ON SPACE BIOSCIENCE 5 p refs (See N67-32250 18-04)

3. SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAM DIVISION. VOLUME II: ENVIRONMENTAL BIOLOGY F. Hong and L. A. Kulp 78 p refs (See N67-32251 18-04)

4. SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAM DIVISION. VOLUME III: EXOBIOLOGY F. Hong and L. A. Kulp 102 p refs (See N67-32252 18-04)

5. SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME IV: PHYSICAL BIOLOGY F. Hong and L. A. Kulp 42 p refs (See N67-32253 18-04)

6. SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME V: PLANETARY QUARANTINE F. Hong, L. A. Kulp, and D. E. Wright 42 p refs (See N67-32254 18-04)

7. SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME VI: BIOSCIENCE COMMUNICATIONS F. Hong and L. A. Kulp 17 p refs (See N67-32255 18-04)

N67-32249*# George Washington Univ., Washington, D. C.
BIBLIOGRAPHY ON APPLICATIONS OF ETHYLENE OXIDE
Donald E. Wright and Ann K. Sarrell *In its* Biol. Sci. Commun. Proj. 30 Jun. 1967 33 p refs (See N67-32248 18-04)

A bibliography is presented on the application of ethylene oxide gas to the sterilization of spacecraft surfaces. Also included are a subject index, in which key words in the title of each referenced work have been rotated to the beginning of the title and alphabetized, and an author index. R.N.A.

N67-32250*# George Washington Univ., Washington, D. C.
BIBLIOGRAPHY ON SPACE BIOSCIENCE
In its Biol. Sci. Commun. Proj. 30 Jun. 1967 5 p refs (See N67-32248 18-04)

An annotated bibliography on aerospace medicine and biology is presented. Many of the reference works are bibliographies on the same topic. R.N.A.

N67-32251*# George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAM DIVISION. VOLUME II: ENVIRONMENTAL BIOLOGY
Frances Hong and L. A. Kulp *In its* Biol. Sci. Comm. Proj. 30 Jun. 1967 78 p refs (See N67-32248 18-04)

An annotated bibliography on environmental biology is presented. The literature citations are listed chronologically and by author. Author and permuted title indices are included along with addresses of the senior authors and laboratories. An analysis of the publication sources is also given which provides an indication of the activity and direction of research within this field. R.N.A.

N67-32262*# George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAM DIVISION. VOLUME III: EXOBIOLOGY
Frances Hong and L. A. Kulp *In its* Biol. Sci. Comm. Proj. 30 Jun. 1967 102 p refs (See N67-32248 18-04)

An annotated bibliography on exobiology is given. The references are listed chronologically and according to author. Author and permuted title indices and addresses of senior authors and laboratories are listed. An analysis of the publication sources is included to provide an indication of the research activity and direction in this field. R.N.A.

N67-32263*# George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME IV: PHYSICAL BIOLOGY
Frances Hong and L. A. Kulp *In its* Biol. Sci. Comm. Proj. 30 Jun. 1967 42 p refs (See N67-32248 18-04)

Literature citations to research in physical biology are listed chronologically and by author in this bibliography. Author and permuted title indices are listed along with addresses of senior authors and laboratories. An analysis of the publication sources provides some statistics on the extent and direction of research within the field. R.N.A.

N67-32264*# George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME V: PLANETARY QUARANTINE
Frances Hong, L. A. Kulp, and D. E. Wright *In its* Biol. Sci. Comm. Proj. 30 Jun. 1967 42 p refs (See N67-32248 18-04)

This bibliography contains citations to publications on research concerned with planetary quarantine. The references are listed chronologically and by author. Both author and permuted title indices are included as well as lists of senior author and laboratory addresses and journals in which some of the articles appeared. R.N.A.

N67-32265* George Washington Univ., Washington, D. C.
SCIENTIFIC PUBLICATIONS OF THE BIOSCIENCE PROGRAMS DIVISION. VOLUME VI: BIOSCIENCE COMMUNICATIONS
Frances Hong and L. A. Kulp *In its* Biol. Sci. Comm. Proj. 30 Jul. 1967 17 p refs (See N67-32248 18-04)

References to literature on bioscience communications research are listed chronologically and according to author in this short bibliography. Also included are author and permuted title indices and addresses of the senior authors and laboratories. R.N.A.

N67-32310 Institute of Modern Languages, Inc., Washington, D. C. Translation and Interpretation Div.
HALLUCINATION BY THE ELECTRICAL STIMULATION OF TEMPORAL LOBE
H. Hori 31 Mar. 1967 17 p refs Transl. into ENGLISH from Seishin Shinkeigaku Zasshi (Tokyo), v. 64, 1962 p 1010–1017

Electric stimulation of the temporal lobe was tested as a method of treating hallucinations in 17 chronic schizophrenic patients. The hallucination produced by electric stimulation was generally different than the hallucination usually experienced by the patient. Visual hallucinations were produced more frequently than any other kind. The hallucinations were more perceptive than symbolic in nature and their content had little relation with the patient's original hallucination. Emotional change had little to do with the occurrence of hallucinations. Visual hallucinations occurred over the entire superior gyrus and also deep in the temporal lobe, while auditory hallucinations only occurred in the front of the superior gyrus. When a patient experiencing an auditory hallucination was electrically stimulated, the hallucination either changed or disappeared. A hypothesis is made that the perception of change is sound and the hallucination of body sensation may be the physiological basis of hallucination, i.e., auditory hallucination presumably comes from a change in the system of perception, based on some physiological function, together with a psychological counterpart. R.N.A.

N67-32317*# National Aeronautics and Space Administration, Washington, D. C.
CERTAIN ASPECTS CONCERNING OXYGEN METABOLISM OF THE BODY EXPOSED TO PROLONGED ACCELERATIONS [NEKOTORRYE STORONY KISLORODNOGO OBMENA ORGANIZMA PRI DLITERL'NO DEYSTVUYUSHCHIKH USKORENIYAKH]
Ye. I. Sorokina Aug. 1967 7 p refs Transl. into ENGLISH from Kosmicheskaya Biol. i Med., (USSR), vol. 1, no. 2, 1967 p 26–30
(NASA-TT-F-11135) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Changes in oxygen metabolism of muscular and brain tissues of animals exposed to prolonged transverse accelerations (oxygen tension and redox potential) are described. The total oxygen consumption and body temperature under the same conditions. A many-faceted approach to the processes studied allows us to establish new regularities in oxygen metabolism of muscular and brain tissues. Their evaluation helps to understand the role of the changes in tolerance of the body for accelerations on the whole. Author

N67-32331*# National Aeronautics and Space Administration, Washington, D. C.
STUDY OF SLEEP CHARACTERISTICS UNDER CONDITIONS OF SIMULATED MANNED SPACE FLIGHT [IZUCHENIYE OSOBENNOSTEY SNA V USLOVIYAKH, MODELIRUYUSHCHIKH KOSMICHESKIY POLET]
V. I. Myasnikov Aug. 1967 7 p refs Transl. into ENGLISH from Kosmich. Biol. i Med. (USSR), vol. 1, no. 2, 1967 p 59–63
(NASA-TT-F-11138) CFSTI: HC $3.00/MF $0.65 CSCL 06S

To determine factors for protecting spacecraft crews on long-duration missions from environmental hazards and physiological stress, characteristics of sleep patterns in their relation to adaptation and resistance of the organism were studied. Data are given on reactions to protracted exposure to noise, angular acceleration, and isolation in their effect on sleep. Impairment of sleep included difficult wake–sleep transition and semiwakefulness. Correlation of sleep with functional changes is demonstrated with respect to motion sickness and impaired acoustic adaptation. The significance of differential diagnosis of somnolent, precollaptoid, and fatigue states is emphasized. Author

N67-32362*# National Aeronautics and Space Administration. Washington, D. C.

STUDY OF THE WORK AND REST CYCLES OF TEST SUBJECTS EXPOSED TO RELATIVE ISOLATION [IZUCHENIYE REZHIMOV ZHIZNEDEYATEL'NOSTI GRUPPY ISPYTATELEY, NAKHODYASHCHIKHSYA V USLOVIYAKH OTNOSITEL'NOY IZOLYATSII]

N. N. Gurovskiy, B. A. Dushkov, and F. P. Kosmolinskiy Aug. 1967 7 p refs Transl. into ENGLISH from Kosmich Biol. i Med. (USSR), vol. I, no. 2, 1967 p 54–59

(NASA-TT-F-11137) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Results of two 15-day experiments on three test subjects in a sealed chamber, with 24- and 18-hour rest and work cycles, are given. The 18-hour cycle had a greater effect on psychic functions, cardiovascular system, nervous and muscular activity, and caused more pronounced biochemical changes, indicating the development of nervous and emotional stress. Objective and subjective observations on reaction of the organism to the two cycles are tabulated and plotted. Author

N67-32363# Geoscience, Ltd., La Jolla, Calif.

WHOLE ORGAN FREEZING AND THAWING HEAT TRANSFER AND THERMAL PROPERTIES Annual Report, 1 Apr. 1966–31 Mar. 1967

Heinz F. Poppendiek, Norman D. Greene, R. Randall, and H. G. Furgerson 31 Mar. 1967 35 p refs

(Contract Nonr-4095(00))

(GLR-54; AD-653101) CFSTI: HC $3.00/MF $0.65

An alternate thermal conductivity device (cylindrical geometry) has been constructed and used to compliment the flat plate apparatus. Some thermal conductivity measurements for ice over the temperature range of 20F to -320F have been obtained and compared to literature values. Some difficulties have been encountered with entrapped air. Conductivity measurements for bovine liver in the unfrozen and frozen states were also made and compared to the behavior of water and ice. On the basis of the composition of liver, the results for liver were in reasonable agreement with the data for ice and water. A thermal gradient calorimeter has been designed, fabricated, calibrated and used to study the heat capacities of biological specimens. Heat capacity measurements have been made for ice, water, frozen bovine liver, kidney, skin, spleen, heart and calf liver. These heat capacity measurements were compared to the values known for water and ice. A graphical or numerical heat transfer procedure has been used to perform freezing calculations that are applicable to transient freeze-thaw heat transfer in organ and tissue storage. Specifically, the time-temperature histories in idealized slab organs with different amounts of water content have been calculated. Also, an analytical heating solution has been derived that defines the initial portion of the thawing history in a biological material that has embedded iron particles that are heated by electromagnetic induction. Author (TAB)

N67-32384# Army Environmental Hygiene Agency, Edgewood Arsenal, Md.

MICROWAVE HAZARDS BIBLIOGRAPHY, APRIL 1967

Apr. 1967 40 p refs

(AD-652788) CFSTI: HC $3.00/MF $0.65

The bibliography provides a source of references for those interested in the biological effects and the evaluation of hazards associated with microwave generating equipment. The references are categorized into four principal sections: biological effects; ocular effects; occupational health aspects; and instrumentation, measurements, and technical evaluation of microwave equipment. TAB

N67-32386# Georgetown Univ., Washington, D. C. Dept. of Biology.

PERFORMANCE OF SMALL MAMMALS AT LOW BODY TEMPERATURES Progress Report

Joseph A. Panuska 30 Apr. 1967 17 p refs

(Contract DA-49-193-MD-2668)

(AD-653127) CFSTI: HC $3.00/MF $0.65

The study evaluates the effect of progressively induced low body temperature on trained performance. Approaches to the cause or causes of performance failure at critical body temperature levels are also presented. The value of the performance temperature suppression method for further behavioral study is proposed. Trained heat reinforcement performance was suppressed in the guinea pig at the same body temperature range as was previously reported for the rat, 23 - 25C, several degrees above the level of complete motor collapse. Other rodents and other behavioral methods were also used in the performance evaluations of unrestrained hypothermic subjects. Physiological studies begun include regional brain lipid analysis and a measurement of cerebral blood flow under the conditions of the hypothermia behavioral studies. A supplementary study on the effect of Dimethylsulfoxide on cold-exposed animals revealed a significant depression of oxygen consumption. This is related to the previously reported acceleration of cooling rate. DMSO, however, caused no additional depression on heart rate during whole body cooling. Author (TAB)

N67-32461# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.

TOXICOLOGY AND PATHOLOGY OF REPEATED DOSES OF MONOMETHYLHYDRAZINE IN MONKEYS Final Report, Apr.–Jul. 1964

Kenneth C. Back and Mildred K. Pinkerton Feb. 1967 20 p refs

(AMRL-TR-66-199; AD-652846) CFSTI: HC $3.00/MF $0.65

The effects of daily repeated doses of monomethylhydrazine (MMH) were studied in monkeys. Groups of monkeys were given from 2.5 to 5 mg/kg MMH i.p. for a total of 23 doses. Other monkeys were given from 7 to 10 mg/kg MMH i.p. for up to 4 days. Baseline and weekly clinical laboratory measurements studied were complete blood count, serum glucose, alkaline phosphatase, and glutamic oxaloacetic transaminase. At the end of the exposures, necropsies were performed on all animals. Special studies included fat stains of fresh cryostat sections of heart, liver, and luxol fast blue stains of pons, cerebellum, basal ganglia, and insular cortex. Results of the experiments have delineated the limits of toxicity for MMH in primates, as evaluated by clinical chemistry, symptomatology, and pathological examination. Repeated doses of 5 mg/kg cause emesis and some convulsions when a total of 15 mg/kg was reached. Animals tolerated daily doses of 2.5 mg/kg for a total of 23 injections with no significant effects. Other animals tolerated 12 doses of 5 mg/kg per day after having received 5 mg/kg each day for 3 days and 2.5 mg/kg for 8 days or 85 mg/kg for a 4-week period. This experiment tends to negate a tolerance phenomenon. The most significant conclusions from the experiments are the relative lack of pathological (either anatomical or clinical) alterations seen in the acute intoxications and the extremely narrow limits between a no-effect and lethal dose level. Of extreme interest is the absence of kidney malfunction or renal pathology in these studies as contrasted by results seen in dogs at these dose levels. MMH causes marked renal damage in dogs. Author (TAB)

N67-32513# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.

EFFECTS OF OVERPRESSURE ON THE EAR: A REVIEW

Frederic G. Hirsch Nov. 1966 38 p refs

(Contract DA-49-146-XZ-372)

(DASA-1858; AD-653129) CFSTI: HC $3.00/MF $0.65

Information regarding blast effects on the ear is reviewed in an attempt to gather quantitative information available for animals and man for help in the establishment of relationships between various levels of overpressure and the incidence of eardrum failure, the degree of damage to the middle and inner ear and other identifiable sequelae referable to cochlear or vestibular functions. Author (TAB)

N67-32519# Miami Univ., Fla. Texas Univ., Austin.
THE MICROBIAL CORROSION OF IRON Final Report, Nov. 1958–Dec. 1964
Carl H. Oppenheimer Mar. 1967 18 p refs
(Contracts Nonr-375(10); Nonr-840(21))
(AD-653368) CFSTI: HC $3.00/MF $0.65

The investigation showed the potential and magnitude for microbial corrosive effects on iron in marine environments. Aerobic and anaerobic corrosion cells can be developed by a wide variety of microorganisms. Aerobic corrosion is developed through metabolic oxygen consumption by bacteria on localized iron surfaces where organic food is present. Alternating bands of aerobic-anaerobic zones are formed in sediments by layering effects of deposition involving different amounts of organic materials. The layering does produce oxygen differential cells that are very corrosive. Anaerobic corrosion cells are produced by depolarization of the iron due to proton or hydrogen uptake. The activity is proportional to hydrogenase activity or to the presence of hydrogen acceptors in the area. Suitable tests involving weight loss of iron test coupons can be employed to show the corrosive nature of microorganisms in the environment. Author (TAB)

N67-32526# Santa Rita Technology, Inc., Menlo Park, Calif.
SPEECH PROCESSING WITH A COCHLEAR-NEURAL ANALOG Final Report, 1 Apr. 1964–31 Mar. 1966
John L. Stewart Wright-Patterson AFB, Ohio, AMRL, Feb. 1967 151 p refs
(Contract AF 33(615)-1763)
(AMRL-TR-66-229; AD-653207) CFSTI: HC $3.00/MF $0.65

The investigation concerns activities pursued in improving our understanding of the nature of the ears transformation of acoustic information to neural form. The current configuration of the analog ear developed by Santa Rita Technology is presented and design parameters are covered in detail. A model is proposed of a neural analyzer which extracts information from sound envelope fluctuations. These functional processes are thought to be similar to those employed by certain insects. By combining neural analysis with cochlear mechanisms, it has become possible to define a speech data pre-processing scheme which presents low-rate data in an almost phonetically-structured form to more central regions of the nervous system. Behavior of a physical neural analysis simulator is described and the nature of a complete phonetic-like speech display is estimated. Author (TAB)

N67-32542# Aerojet-General Corp., Dayton, Ohio.
INHALATION TOXICITY OF PYROLYSIS PRODUCTS OF MONOBROMOMONOCHLOROMETHANE (CB) AND MONOBROMOTRIFLUOROMETHANE (BrF_3) Final Report, Sep. 1965–Jun. 1966
Charles C. Haun, Edmond H. Vernot, J. D. MacEwen, David L. Geiger, James M. McNerney et al Wright-Patterson AFB, Ohio, AMRL Mar. 1967 34 p refs
(Contract AF 33(657)-11305)
(Rept.-3320; AMRL-TR-66-240; AD-652850) CFSTI: HC $3.00/MF $0.65

The toxicities of the pyrolysis products of two fire extinguishant compounds, CH2ClBr and CBrF3, were investigated using albino rats and 14 day LC50 values were determined for single 15-minute exposures. Both fire extinguisher compounds, currently used by the USAF for aircraft fires, were pyrolyzed at 800C in a hydrogen-oxygen flame. The pyrolysis products of each compound were examined and the principle constituents were identified and quantitated. The determined LC50 value of 2300 ppm for pyrolyzed CBrF3 produced a hydrogen fluoride concentration of 2480 ppm consistent with the reported LC50 value for a single 15-minute exposure to this gas. Monobromomonochloromethane pyrolysis products were found to have a LC50 of 465 ppm (as CH2ClBr) under the experimental parameters tested. The toxic response producing this LC50 value appeared to result from a mixture of hydrogen chloride, hydrogen bromide, and bromine gases. Author (TAB)

N67-32570 Royal Inst. of Tech., Stockholm (Sweden). Speech Transmission Lab.
QUARTERLY PROGRESS AND STATUS REPORT, OCTOBER–DECEMBER 1966
15 Jan. 1967 62 p refs
(STL-QPSR-4/1966)

Various activities in the area of speech communication research are reported. The theory of distinctive features in linguistics is defined. Speech production and analysis studies focused on testing of an improved version of the Fabre electrical glottograph with respect to its potentialities in voice research. Vocal tract size factors and nonuniform F-pattern scalings are also considered. Speech perception experiments involved consonant confusions in English and Swedish. The source spectrum of double-reed woodwind instruments was analyzed for musical acoustics data. S.P.

N67-32617*# Research Triangle Inst., Durham, N. C. Solid State Lab.
BIOMEDICAL APPLICATIONS OF NASA SCIENCE AND TECHNOLOGY Quarterly Progress Report, 15 Dec. 1966–14 Mar. 1967
J. N. Brown, Jr. 14 Mar. 1967 42 p refs
(Contract NSR-34-004-035)
(NASA-CR-85969; EU-279; QPR-3) CFSTI: HC $3.00/MF $0.65
CSCL 06B

Efforts continued on the overall objectives of identifying existing problems in the field of biomedicine which appear to be solvable by the application of aerospace science and technology, and of identifying technology or concepts leading to solutions of these problems. Five technology transfers are discussed: correction for latency in vidicons, spherical aberration in ultrasonic holograms, low temperature lubricant for microtomes, aberrations in holography, and analysis of electrophoresed samples. Potential transfers of technology are also discussed. These pertain to calculation of left ventricular volume from cineradiographs, oxygen measurements in gas mixtures, microforce transducer, intracavitary radiation probe, prosthetic urethral valve, biomedical tape recorder, methods of studying diseased bone joints, and bone growth and resorption. The biomedical problem abstract concept, and the manner in which it is implemented, is assessed. M.G.J.

N67-32618*# Research Triangle Inst., Durham, N. C. Solid State Lab.
BIOMEDICAL PROBLEM ABSTRACTS
In its Biomed. Appl. of NASA Sci. and Technol. 14 Mar. 1967 8 p (See N67-32617 18-04)

As the problem abstract concept is considered an effective means of identifying advanced technology for application to medical existing medical problems, two sample abstracts which were sent to NASA personnel are presented. The objective was to call attention to the significant barriers that impede the progress of biomedical research and health care. In the abstracts, the problem is stated to show the need for a prosthetic urethral valve which can be implanted in the male urethra to allow the bladder to be emptied, and which can be controlled from outside the body; and for a nondirectional small-aperture transducer for ultrasonic holograms. Background data are presented to show the levels of research activites, and the significance of possible solutions to medical research, clinical practice, or patient treatment and care. M.G.J.

N67-32824# Army Medical Research Lab., Fort Knox, Ky.
THE RELATION OF INDUCED TINNITUS TO PHYSICAL CHARACTERISTICS OF THE INDUCING STIMULI Interim Report

Michal Loeb and Richard P. Smith (Louisville Univ.) 10 May. 1967 14 p refs
(AMRL-729; AD-652706) CFSTI: HC $3.00/MF $0.65

After observers were exposed to intense pure tone and broad band acoustic stimuli, their temporary threshold shifts were measured, and they were asked to match the pitch of any resulting tinnitus by manipulating the frequency of an adjustable low-level pure tone in the opposite ear. It was found that both the frequency of tinnitus and the frequency of the tone used for the pitch match increased as the frequency of the traumatic stimulus increased, but maximum loss frequency and tinnitus frequency did not coincide. Although the observers were quite reliable in their judgments of tinnitus elicited by a stimulus, inter-observer variability was considerable. Author (TAB)

N67-32632* Texas Womans Univ., Denton. Research Inst.
PHYSICAL AND BIOCHEMICAL CHANGES OCCURRING IN BONE AS A RESULT OF GRAVITY COUNTERACTION Semiannual Report
George P. Vose 30 Jun. 1967 32 p refs
(Grant NGR-44-013-005)
(NASA-CR-87001; EM-N-101; SAR-1) CFSTI: HC $3.00 CSCL 06C

Four adult beagles were maintained in metabolic cages during 16-days of equilibration prior to a 32-day period in a water-buoyance environment. Radiographic bone densitometry during the water immersion period revealed conspicuous decreases in bone mass in the distal radius and slight decreases in the middle metacarpal. The magnitude of calcium loss in the distal radius was estimated to be approximately 5 mg per day. In the os calcis, however, slight increases occurred in three of the four dogs. After 27 days of the recovery period three of the four dogs had regained their initial bone mass in the distal radius but recovery was still incomplete in the metacarpal. Bone formation rate as determined by tetracycline labeling prior to and at the close of the immersion period indicated that bone apposition was at least as rapid in the femur of the experimental dogs as in the non-immersed control dog. No significant differences in bone ash and calcium content were noted between the experimental dogs and the control dog. Various means of limb immobilization and methods of tetracycline administration were also investigated. Author

N67-32644# School of Aerospace Medicine, Brooks AFB, Tex.
TOXICITY OF MONOMETHYLHYDRAZINE ON THE FROG CORNEA Progress Report 16 Apr.–15 Sep. 1966
Walter N. Scott Mar. 1967 14 p refs
(SAM-TR-67-22; AD-652204) CFSTI: HC $3.00/MF $0.65

The effect of monomethylhydrazine (MMH) on the in vitro frog cornea was studied. Parameters examined were corneal transparency, membrane potential difference (P.D.), and chloride transport as evidenced by the short-circuit current. MMH caused a diminution in the transparency, a decrease in the short-circuit current, and a fall in the tissue P.D. These effects were slightly ameliorated by subsequent treatment of the tissue with arginine. Author (TAB)

N67-32649# Navy Experimental Diving Unit, Washington, D. C.
INTERRELATIONSHIPS OF SEVERAL PARAMETERS OF DECOMPRESSION SICKNESS
R. E. Doll, and T. E. Berghage 1 Mar. 1967 39 p refs
(RR-7-65; AD-652382) CFSTI: HC $3.00/MF $0.65

The report gives the results of an analysis of the interrelationships of several parameters of decompression sickness. This study was based on 348 case reports of decompression sickness among U. S. Navy divers on file at the U. S. Navy Experimental Diving Unit for the years 1956 - 1962. The dives resulting in decompression sickness were divided into 3 groups: (1) single air dives, (2) HeO2 dives, (3) repetitive air dives. The single air dive group was divided into 9 statistically different type dives. Relationships between dive type and 10 parameters were determined. The parameters investigated were: (1) age, (2) body build, (3) severity of work performed during dive, (4) delay between onset of symptoms and treatment, (5) number of symptoms, (6) number of locations (i.e. where symptoms appeared), (7) organ system involved, (8) type of treatment, (9) time of onset of symptoms, and (10) results of treatment. The HeO2 group was matched against part of the air dive group in terms of depths and bottom times. Relationships again were determined between the above mentioned parameters and breathing medium (i.e. air vs HeO2). Intercorrelation matrices for each of the 3 groups were computed on 8 parameters. Findings revealed that dive type correlated with the three variables: age, type of work, and delay between onset of symptoms and treatment. The remaining seven parameters appear to be independent of dive type. Several interrelationships between parameters were noted and are shown in three intercorrelation matrices. Author (TAB)

N67-32660# School of Aerospace Medicine, Brooks AFB, Tex.
EFFECT OF FLOW RATE ON PAROTID FLUID CALCIUM, MAGNESIUM, AND PROTEIN CONCENTRATIONS IN THE HUMAN Report for Sep. 1965–Sep. 1966
Stewart A. Windeler, Jr., and Ira L. Shannon Feb. 1967 12 p refs
(SAM-TR-67-18; AD-652206) CFSTI: HC $3.00/MF $0.65

A single sample of parotid fluid was collected from 23 healthy young adult males under conditions of no exogenous stimulation. Each subject also provided seven additional samples collected under varying conditions of stimulation. Rates of flow were purposely controlled in an ascending-descending pattern to provide optimal conditions for studying the effect of different rates of gland function. Calcium, magnesium, and total protein were determined. Calcium concentration was positively correlated with rate of flow ($r = .775$, $P < .01$); protein level was likewise positively related to flow rate ($r = .558$, $P < .01$); magnesium concentration was negatively related to flow ($r = -.666$, $P < .01$). The complexing of calcium by protein could feasibly account for the diametrically opposing secretory patterns found for these divalent cations of the alkaline earth group. Author (TAB)

N67-32670# Army Aeromedical Research Unit, Fort Rucker, Ala.
FUNCTIONAL ORGANIZATION OF BRAIN STEM RESPIRATORY COMPLEX IN THE CAT
Pei Chin Tang 7 Mar. 1967 31 p refs Prepared jointly with Naval Aerospace Medical Inst.
(NAMI-1001; AMRU-JR-67-1; AD-652370) CFSTI: HC $3.00/MF $0.65

A study was made on the roles of the Hering-Breuer reflex, the pneumotaxic center, the apneustic center, and the medullary respiratory center in the regulation of rate and depth of respiration in response to changes in blood concentration of CO2 and O2. Integrated phrenic nerve discharge, abdominal respiratory movement, and intra-abdominal and intratracheal pressures were recorded in decerebrate cats as they breathed air, 5% CO2, 7% CO2, 10% O2 and 100% O2. By using decerebrate cats as control, results from vagotomy, pneumotaxic center ablation, and brain stem transection, alone or in combination, indicate: (1) Hering-Breuer reflex controls respiratory rate and in the absence of pneumotaxic center, maintains a constant depth; (2) pneumotaxic center controls respiratory depth and in the absence of Hering-Breuer reflex, maintains a constant rate; (3) apneustic center provides maximum respiratory depth and prolonged inspiratory duration so that rate can be regulated by Hering-Breuer reflex and depth by pneumotaxic center; (4) medullary respiratory center serves as a final pathway and integration center of the impulses from the higher centers. Author (TAB)

N67-32673# Army Aeromedical Research Unit, Fort Rucker, Ala.
THE INFLUENCE OF ALCOHOL AND DRAMAINE, ALONE AND IN COMBINATION, ON PSYCHOMOTOR PERFORMANCE
Pei Chin Tang and Robert Rosenstein Mar. 1967 18 p refs Prepared jointly with Naval Aerospace Medical Inst.
(NAMI-1002; AMRU-JR-67-2; AD-652369) CFSTI: HC $3.00/MF $0.65

The effect of alcohol and Dramamine, alone and in combination, on the performance of four young adult subjects on the Scow complex coordinator was studied in eight experiments. Alcohol alone produced a 12.5% decrease in performance when the blood alcohol level was between 44 and 50 mg%. When the blood alcohol decreased to the 35 mg% level, the performance decrement became insignificant. Dramamine alone in dosage of 100 mg per person produced relatively small performance decreases (max. 6%). The combination of alcohol with Dramamine produced much larger performance decrements. During the first three hours following ingestion of Dramamine and alcohol, the performance decrements were 8%, 25%, and 9%, respectively, when the blood alcohol levels were 50, 44, and 34 mg%, respectively. Reasons for not recommending a maximum permissible alcohol level for airmen are discussed. Author (TAB)

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-31637*# Stanford Univ., Calif. Div. of Engineering Mechanics.
THE REORIENTATION OF A HUMAN BEING IN FREE FALL
Preston G. Smith and Thomas R. Kane May 1967 108 p refs
(Grant NGR-05-020-209)
(NASA-CR-86671; TR-171) CSCL 06P

How a freely falling human being can change the orientation (attitude) of his body by moving parts of the body relative to each other is discussed. To this end, four models of the human body are studied in connection with the following two problems: 1) How does the orientation of each part of the body change when the relative motions of the parts proceed in certain specified ways? 2) How, if at all, can the parts be moved relative to each other so as to bring the model from a given initial state to a given final state? In both problems it is assumed that the system is initially at rest so far as rotational motion is concerned. In the case of the first problem, results are presented for each of the four models considered; in three instances these results are in the form of plots showing possible re-orientations for a typical human being. A general method of solution is given for the second problem, and this method is applied to a model of the human body. Author

N67-31635*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
PILOTING PROBLEMS ASSOCIATED WITH THE SUPERSONIC-TRANSPORT MISSION PROFILE
Glen W. Stinnett, Alan E. Faye, Jr., and Emmett D. Fry *In* NASA. Langley Res. Center Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 485-494
(See N67-31606 18-02)

Conventional instrument displays appear to present inadequate pitch-attitude information at the higher speeds. The addition of velocity-error information and an instantaneous rate-of-climb indicator resulted in improved performance. Overshoot problems at the top of the climb require very timely throttle adjustment because of the large excess of thrust available at full throttle. An unstable thrust–speed relationship at cruise caused a need for continuous throttle adjustment and suggests a need for some type of speed sensitive fuel-control unit. In order to achieve an emergency-type descent from cruise conditions at an altitude of 70,000 ft to 40,000 ft in 2 minutes, an incremental drag coefficient of 0.025 was found necessary. Author

N67-31643*# Naval School of Aviation Medicine, Pensacola, Fla.
TRENDS IN SYSTOLIC BLOOD PRESSURE IN THE THOUSAND AVIATOR COHORT OVER A 24-YEAR PERIOD
Albert Oberman, Norman E. Lane, William R. Harlan, Jr., Ashton Graybiel, and Robert E. Mitchell 25 Apr. 1967 22 p refs
(NASA Order R-136)
(NASA-CR-85973; NAMI-1004) CFSTI: HC $3.00/MF $0.65 CSCL 06P

A cohort of 1056 normotensive, healthy, young men initially examined in 1940 at the mean age of 24 years was followed at three periodic intervals until 1964. The cohort demonstrated little change in mean systolic blood pressure beyond age 35; a portion of this cohort showed no rise of systolic blood pressure with age. If the men are classified according to systolic blood pressure in 1940, those men in the upper quintile tend to remain high; when classified by quintile in 1951, those men at the extremes maintained their relative position for the period of the study. Predictive utility of a systolic blood pressure may be a function of its actual level as well as the age of the individual. Two factors further influenced the systolic blood pressure of this cohort, namely parental longevity and weight gain independent of arm circumference. The effect of those factors separately and in combination changed as the cohort grew older. Author

N67-31808*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
FULL-SCALE FLIGHT TEST OF A PROPOSED ABORT-ESCAPE SYSTEM FOR A MANNED SPACE CAPSULE FROM SEA LEVEL
Willard S. Blanchard, Jr. and Sherwood Hoffman Washington, NASA, Aug. 1960 34 p
(NASA-TM-X-351) CSCL 06G (Declassified)

A proposed system designed to provide safe escape for a manned space capsule during the atmospheric part of boosted flight was investigated to determine its ability to function properly in case of booster-rocket malfunction at or near take-off. An escape tower, or pylon, with an XM19 (Recruit) rocket motor was mounted on the small end of the capsule. A parachute was employed for landing. The escape system performed satisfactorily. Maximum accelerations were within the tolerances of a properly supported and positioned human. The main parachute provided a stabilized sinking rate of about 32 feet per second at sea level. Author

N67-31916# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
METHODOLOGICAL STUDIES OF TRACKING BEHAVIOR: THE EFFECT OF VARIOUS SUPPLEMENTAL INFORMATION FEEDBACKS Final Report, 1 Jun. 1965–31 May 1966
Jane L. Ward and John W. Sanders 13 Dec. 1966 65 p refs
(Contract Nonr-4605(00))
(BBN-1458; AD-649574) CFSTI: HC $3.00/MF $0.65

An experiment was run to explore the use of a direct way of shaping the behavior of human trackers through the use of a visually displayed signal which was a function of the scoring criterion. It had been expected that with a complex criterion, a time-weighted one for example, it would be difficult for a tracker to remember exactly what was desired of him at various times, and that a supplemental way of presenting the information would facilitate his task. The supplemental information was provided by a computed 'criterion circle' which surrounded the error display and whose diameter varied as a function of the computed criterion. Two

criteria were used: a simple 'average error' and a time-weighted error. Both performance scores, in terms of the two criteria, and Bode plots were computed after initial training was completed. The on-line information improved the performance on the simple criterion but, contrary to expectation, reduced performance on the complex one. On the basis of the Bode plots, it appears that the supplemental information required attention of the tracker and interfered with his primary task performance. Apparently any added non-redundant visual signal interferes with the performance on the main task. On the other hand, a properly stated set of instructions can be applied by the subject without cost. Author (TAB)

N67-31917# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
APPENDIX II: SIGNAL ANALYZER I. A SIGNAL ANALYSIS SYSTEM FOR MANUAL CONTROL STUDIES
Mario C. Grignetti, Ronald V. Payne, and Jerome I. Elkind *In its* Methodological Studies of Tracking Behavior 13 Dec. 1966 p 49–57 *refs* (See N67-31916 18-05)
(Contract NASw-668)

Signal Analyzer I is a system of programs written for the DEC-PDP-1 digital computer. The system is designed so that data coming from a manual control experiment is fed to the computer, digitized, indexed, and stored. Analysis of the signals and modelling of the human operator's transfer function follow immediately, allowing the experimenter to set up the next run of his experiment according to the conclusions drawn from the analysis just performed, while subject and apparatus are still available. A major part of the effort was dedicated to the human engineering aspects of the system. Thus, results are displayed in easily interpretable graphical or tabular form and task selection is performed by means of displays where an arrow is pointed to the desired command. Author

N67-32125# George Washington Univ., Alexandria, Va.
AN ANNOTATED BIBLIOGRAPHY ON THE DESIGN OF INSTRUCTIONAL SYSTEMS
Robert G. Smith, Jr. May 1967 140 p refs
(Contract DA-44-188-ARO-2)
(TR-67-5; AD-653128) CFSTI: HC $3.00/MF $0.65

The bibliography is divided into seven major areas, each dealing with a different aspect of instructional system design: (1) Systems--General; (2) Training Systems; (3) Presentation of Knowledge; (4) Practice of Knowledge; (5) Practice of Performance; (6) Management of Students; and (7) Additional Material. The major areas are further divided into subtopics where appropriate. There are 449 annotated entries in the bibliography, dating from 1950 to 1965. Key-word-in-context (KWIC) and author indexes are included. Author (TAB)

N67-32247# Air Products and Chemicals, Inc., Allentown, Pa.
OXYGEN SUPPLY SYSTEM FOR MANNED SPACE ENCLOSURES Final Report, 1 Dec. 1965–30 Sep. 1966
George E. Schmauch and Bruce Bailey Wright-Patterson AFB, Ohio, AMRL, Dec. 1966 62 p refs
(Contract AF 33(615)-3335)
(AMRL-TR-66-169; AD-652247) CFSTI: HC $3.00/MF $0.65

The study was conducted to design, construct, and test an Oxygen Supply System for Manned Space Enclosures. The system was designed to provide oxygen at a rate of 0-91 grams/hr (0-0.2 lbs/hr) for a period of 24 hours, under weightless conditions. The design utilized the catalytic decomposition of hydrogen peroxide to breathing oxygen and potable water on demand. It consists of a positive expulsion peroxide storage tank, a catalytic reactor, a heat exchanger, a gravity independent phase separator, and a product storage tank. A laboratory model was constructed and tested to demonstrate the feasibility of the design. This unit produces breathing oxygen and potable water at the design capacity in any gravitational orientation. Author (TAB)

N67-32271*# Serendipity Associates, Los Altos, Calif.
THE USE OF A VISUAL TESTING APPARATUS FOR SPACE APPLICATION Final Report
A. J. Hoisman and A. Moots Apr. 1967 84 p refs
(Contract NAS2-3725)
(NASA-CR-73099; TR-45-67-3) CFSTI: HC $3.00/MF $0.65
CSCL 05E

A description is presented of support services for the calibration and development of optimum utilization plans for a visual parameter tester applicable to manned space flight. This device provides a testing environment for visual acuity, and several other key vision parameters such as absolute and relative brightness and flicker fusion. Major areas covered include calibration procedures, a pilot study to determine appropriate paradigms to be used for full-scale investigatory effort (presentation order, darkness adaptation, response ranges, ambient conditions, data reduction needs, control conditions), and comparisons of visual acuity. C.T.C.

N67-32314# Applied Psychological Services, Wayne, Pa.
VALIDATION OF THE DEI TECHNIQUE FOR LARGE-SCALE DISPLAY EVALUATION Final Report, Feb. 1966–Mar. 1967
Arthur I. Siegel and Philip J. Federman Griffiss AFB, N. Y., RADC, May 1967 108 p refs
(Contract AF 30(602)-4056)
(RADC-TR-67-134; AD-653209) CFSTI: HC $3.00/MF $0.65

The validity of the display evaluative index technique was investigated in two separate studies. Both studies indicated adequate predictive validity for the technique. The ability of the technique to predict decision making was found to be superior to its ability to predict information extraction processes. Generally, it was found that pictorial type displays are superior to tabular displays for decision making; no difference seemed manifest between the two display types for information extraction. Adding appropriate color coding seemed to augment the ability of the user to employ display information. As fact density increased, display decision making scores decreased. TAB

N67-32466# General Dynamics Corp., Groton, Conn. Electric Boat Div.
HUMAN INFORMATION TRANSMISSION WITH DIFFERENT ENCODING PROCEDURES FOR BINARY STIMULI
Jerry C. Lamb and Herbert Kaufman (Conn. Univ.) 18 Nov. 1966 30 p refs Prepared in cooperation with Conn. Univ.
(Contract Nonr-2512(00))
(U417-66-035; AD-653277) CFSTI: HC $3.00/MF $0.65

Twelve subjects took part in an experiment involving a continuous information transmission task. Three different code types and two levels of stimulus redundancy were used; the stimuli were binary digits and the subjects task was to code the stimuli into verbal equivalents of letters of the English alphabet. The results indicate that transmission rate is unaffected over the range of variables used in the study, i.e., subjects transmit information at a constant rate under a variety of experimental conditions. Author (TAB)

N67-32481# Computer Command and Control Co., Washington, D. C.
LANGUAGE FACILITIES FOR A MAN, A MACHINE, AND RELATIONAL DATA
William C. Mann 28 Apr. 1967 46 p refs
(Contract Nonr-4815(00))
(Rept.-106-2; AD-651973) CFSTI: HC $3.00/MF $0.65

The report concerns the design of a man-machine information system in which the storage and manipulation of relational sentences is a major activity. The language for man-to-machine communication is discussed and a number of features are recommended for implementation, including maintenance of separate, identified sets of statements; strong definition facilities; specific

error-correction features; explicit use of true, false, and unknown sentence values; and embedding in a conventional algorithmic program package. The introduction includes a discussion of the basis of language design and some factors which make synthetic languages subjectively unsatisfying. Author (TAB)

N67-32482# Honeywell, Inc., St. Paul, Minn. Research Dept.
A STUDY OF VISUAL SEARCH USING EYE MOVEMENT RECORDINGS Annual Report, 1 Jan. 1966–31 Mar. 1967
L. G. Williams 28 Mar. 1967 77 p ref
(Contract Nonr-4774(00))
(Rept.-12009-IR-3; AD-652735) CFSTI: HC $3.00/MF $0.65

The report discusses two experimental investigations, one on the effect of target-size specification, the other on the effect of color specification. It was found that when the size of the target was specified to the searcher, the likelihood of a fixation falling on an object in the search field depended almost entirely on the ratio of the specified target size to the object size. The likelihood of fixation was found to be essentially independent of the range of object sizes in the field, the average size of the objects, the number of different-sized objects, or the lightness of the objects in the field. The largest objects in the field were discriminated better than other sizes. Other differences between sizes were minor. It was found that the discrimination gradient for colors was approximately the same throughout the Munsell color space. In particular, when searching for a target of given color, subjects were 50 percent as likely to fixate objects of different color which is: 5 Munsell hue units removed from the target; or 1 Munsell lightness unit removed from the target; or 3 Munsell chroma units removed from the target. These results, together with data previously obtained, provide a data base for predicting search times for targets in complex fields in the general case. Author (TAB)

N67-32493*# North American Aviation, Inc., Downey, Calif. Life Sciences Operations.
FEASIBILITY OF TECHNIQUES FOR MONITORING PHYSIOLOGICAL VARIABLES WITHOUT ATTACHED SENSORS Final Report
G. Hoover 4 Nov. 1966 55 p refs
(Contract NAS12-1)
(NASA-CR-85022; SID-66-1143) CSCL 06B

A survey of remote or unattached sensors that might be applied to physiological monitoring demonstrates capability for remote measurement of eyeblink, eye movement, and pupillary diameter. Refinement of the necessary instrumentation, signal conditioning equipment, and data analysis equipment appears within the capability of present technology. Programs are recommended to obtain correlations of the parameters of eyeblink, eye movement, and pupil diameter with the classical EEG arousal state and mental tasks. Author

N67-32496# Ohio State Univ. Research Foundation, Columbus.
THE LEARNING BEHAVIOR AND ERGODIC PROPERTY OF FINITE-STATE MARKOV CHAINS Technical Report, 1 Jan. 1966–30 Jun. 1967
J. T. Tou and H. H. Yeh Jun. 1967 38 p refs
(Contract Nonr-495(29))
(Rept.-2; TR-2; AD-653116) CFSTI: HC $3.00/MF $0.65

The dynamic behavior of ergodic finite-state homogeneous Markov chains is studied. An ergodicity test of general natural is formulated. From this general test procedure, various test criteria are derived. One criterion is shown to be both necessary and sufficient. The ergodicity is found to be a topological property of the state flow graph of a finite-state homogeneous Markov chain or an equivalent stochastic automation. The dynamic behavior of an ergodic chain can be explained as a contraction mapping in the probability vector space. The norm of the induced transition probability matrix serves as pessimistic estimation of the learning rate. TAB

N67-32512# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
AIR-BLAST STUDIES WITH EIGHT SPECIES OF MAMMALS
Donald R. Richmond, Edward G. Damon, I. Gerald Bowen, E. Royce Fletcher, and Clayton S. White Aug. 1966 48 p refs
(Contract DA-49-146-XZ-372)
(DASA-1854; AD-653022) CFSTI: HC $3.00/MF $0.65

A series of three experiments were carried out. (1) A total of 204 dogs and 115 goats were exposed to shock-tube and high-explosive-produced reflected shock waves ranging in duration from 400 to 1.5 msec. LD50 values, calculated by probit analysis, showed similar patterns for both species, increasing at the shorter durations by a factor of 4 or 5 above those for long durations. (2) Sixty dogs were exposed in a shock tube to sharp-rising overpressures of near 400-msec duration at six-dose levels ranging from 9.2 to 35.8 psi. The degree of lung injury was graded and threshold for petechial hemorrhage determined. (3) Dose-response curves were compiled using data for 200 mice, 110 hamsters, 150 rats, 120 guinea pigs, 48 cats, and 40 rabbits exposed to long-duration reflected pressures in a shock tube. The tolerances (LD50) for all six species are compared. Pathological observations for all species and lung-weight data for cats and hamsters are included. Criteria for relating biological response to the various parameters of the blast wave are discussed. Author (TAB)

N67-32574# School of Aerospace Medicine, Brooks AFB, Tex.
VECTAN: A DIGITAL COMPUTER PROGRAM FOR THE ANALYSIS OF VECTORCARDIOGRAM DATA, 1 DECEMBER 1964–1 DECEMBER 1966
Brian E. Arment and Lawrence S. Higgins Feb. 1967 29 p refs
(Contract AF 41(609)-2267)
(TI-00110-67-10; AD-652241) CFSTI: HC $3.00/MF $0.65

The report covers the results of an investigation of filtering techniques for the spatial vector velocity function of vectorcardiogram data, the operation of a computer program to perform an interval-measurement analysis of the function, and a qualitative discussion of the results. A second report describes an electronic data acquisition, calibration, and identification system for vectorcardiograms. Author (TAB)

N67-32629# Naval Medical Research Inst., Bethesda, Md.
PROCEDURAL DETAILS FOR PROJECT COMONOT
Seward Smith, Thomas I. Myers, Eugene Johnson, III, Steven L. Milstein, J. Michael Walsh et al Jun. 1967 64 p refs
(Rept.-28; AD-653290) CFSTI: HC $3.00/MF $0.65

A detailed summary is given of the research procedure employed during the first phase of Project COMONOT. COMONOT (comparative monotony) is an experimental assessment of various conditions of boredom and monotony, at one extreme requiring a 7-day stay in a totally dark, sound-proof cubicle. Attention in this paper is focused on: (1) the rationale of the study; (2) definition of the three experimental conditions; (3) a description of the subject population; (4) details of the test program; and (5) how factors affecting experimental set were dealt with. Also included are the actual briefing scripts and test schedules followed. The paper is intended to provide the sorts of additional procedural details that, due to space limitations, usually must be omitted from journal articles. Author (TAB)

N67-32651# University of Southern Calif., Los Angeles. Electronics Personnel Research Group.
MEASUREMENT AND PREDICTION OF COGNITIVE LOADINGS IN CORRECTIVE MAINTENANCE TASKS: II. BAYESIAN ANALYSIS OF A SAMPLE OF CLASS B ELECTRONICS TECHNICIANS' BEHAVIORS
Joseph W. Rigney, Robert H. Cremer, Douglas M. Towne, Nicholas A. Bond, Jr., and Anthony K. Mason. Apr. 1967 35 p refs
(Contract Nonr-228(22))
(TR-52; AD-652363) CFSTI: HC $3.00/MF $0.65

Thirty-six advanced Navy electronics technicians (Class B Electronics School students) were given a symptom-malfunction (S-M) matrix completion test on a blocking oscillator circuit. Next, via a card-simulation format, each technician attempted to solve six troubleshooting problems in the same circuit; records were kept of each voltage and resistance reading made and of each component replacement choice. After the troubleshooting session, the subjects took a retest on the S-M matrix completion test. Using the technicians S-M matrix values, a Bayesian computation was performed for each performance step; this computation yielded Bayesian likelihoods for each replaceable component in the circuit. The Class B technicians showed notably superior performance to an earlier Class A technician sample in terms of troubleshooting time, steps to solution, and the number of correct solutions. The retest showed that as a technician works on search problems in this oscillator, he improves his original subjective S-M matrix on that circuit and appears to learn as a consequence of troubleshooting. The advanced technicians were not appreciably more Bayesian-like in component-replacement choices (about 55% resembled Bayesian performances compared to 52%) than the earlier Class A technician sample. The earlier finding, that S-M matrix quality is related to Bayesian-like component-replacement choices, and several competence indicators were confirmed in this study. Author (TAB)

N67-32652# Applied Pyschological Services, Wayne, Pa.
PERSONNEL PSYCHOPHYSICS: THE FUNCTIONAL RELATIONSHIP BETWEEN JOB COMPLEXITY AND A NUMBER OF ELECTRONIC MAINTENANCE TRAINING VARIABLES
Mark G. Pfeiffer and Arthur I. Siegel Mar. 1967 61 p refs
(Contract Nonr-2279(00))
(AD-652391) CFSTI: HC $3.00/MF $0.65

The study was concerned with the investigation and the establishment of personnel psychophysical functions as predicted by a Naval avionics job model. Magnitude estimation methods were employed to determine the physical correlate values predicted by the model. To describe the physical training continuum, a sample consisting of 20 avionics instructors in the AQ and AT rates made separate magnitude estimations of the number of class hours needed for a total of six different maintenance activities on avionics circuits, the GCT-ARI composite score required for avionics students, the class hours required on activities alone, and the complexity of training devices needed in order to achieve certain fleet maintenance goals of the avionics job. Using the perceived job complexity data, which had been obtained previously in a separate study as the dependent variable, linear correlation and regression procedures were employed to determine whether lawful relationships between the dependent variable and various training correlates could be established. For the combined AQ-AT data, the nine Pearson correlation coefficients derived between the psychological and physical continua were, with two exceptions, all .49 or greater. Thus, it was possible to write lawful psychophysical equations for seven of the total of nine variables investigated. Author (TAB)

N67-32653# School of Aerospace Medicine, Brooks AFB, Tex.
PRELIMINARY STUDIES ON A NEW PARTIAL-PRESSURE SUIT CONCEPT Report for Aug. 1965--Feb. 1966
Jefferson C. Davis, Joseph Boyle, III, and Frederick R. Ritzinger Feb. 1967 13 p refs
(SAM-TR-67-15; AD-652207) CFSTI: HC $3.00/MF $0.65

In preliminary studies, a new partial-pressure suit has been developed as an emergency garment for high-altitude aircraft flight, for continuous wear in extended space flight, and for crewmembers of the proposed supersonic transport. The USAFSAM experimental suit was designed for comfort in the unpressurized state, yet to provide adequate pressure protection at altitude. Mechanical pressure is applied to the skin by expansion of air sealed in rubber tubes sewed between two layers of porous fabric. Air in the tubes expands at altitude according to Boyles law. In manned flights to 75,000 feet, skin pressure measurements are equal to those of the partial-pressure suit; yet at ground level and up to 25,000 to 30,000 feet, shirt sleeve comfort is approached. Author (TAB)

N67-32656# Tufts Univ., Medford, Mass. Inst. for Psychological Research.
RESEARCH INVOLVING COMMUNICATION PROCESSES IN TASK ORIENTED GROUPS Final Report
16 May 1967 30 p
(Contract Nonr-494(15))
(AD-652390) CFSTI: HC $3.00/MF $0.65

Several theoretical articles which examine various aspects of the small group performance problem are discussed. These include: (1) An analysis of the executive process, based on the distribution of information in a group which relates to particular decisions. The general notion was that the information bearing on any action decision can be determined or estimated and that an effective executive structure is one that maximizes the amount of relevant information brought to bear on each decision. (2) An examination of phasing relationships among action units with particular emphasis on measurement. (3) A discussion of the use of computer simulation models with special reference to organization theory. (4) A survey of the possibly appropriate mathematical models for a variety of group performance subfunctions. Author (TAB)

N67-32671# Hebrew Univ., Jerusalem (Israel). Dept. of Psychology
CORRELATES OF AMBIVALENCE, RISK-TAKING AND RIGIDITY Final Scientific Report
A. Minkowich 1 Mar. 1967 433 p refs
(Grant AF-EOAR-32-65)
(AFOSR-67-1157; Rept.-3; AD-652655) CFSTI: HC $3.00/MF $0.65

Construct validity of ambivalence was demonstrated by its relationships with socialization practices, personality traits, risk-taking behavior, perceptual impulsiveness and rigidity, and modes of binocular resolutions. Utilities and outcome-determinants affect relationships of risk-taking with personality and perception variables. Situational factors (eg, previous failure, stress, time interval between choice and performance) greatly influence risk choices. Engaging in risky situations seems to have reward value. TAB

N67-32678# Computer Corp. of America, Cambridge, Mass.
SCENE ANALYSIS USING THE CONCEPT OF MODEL
Adolfo Guzman Jan. 1967 80 p refs
(Contract AF 19(628)-5914)
(AFCRL-67-0133; AD-652017) CFSTI: HC $3.00/MF $0.65

A symbolic notation (FDL-1) for the description of pictures composed of rectilinear segments is developed. Visual objects, aggregates of objects (scenes) and generalized classes of objects (models) may be expressed in this notation. A program is described which, given a scene S and a model of an object O, finds all instances of O in S. (O and S are expressed in FDL-1). The program, written in the language CONVERT, can identify overlapping objects when they are transparent. Examples are given. TAB

N67-32680# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
EVALUATION OF WATER RECLAMATION SYSTEMS AND ANALYSIS OF RECOVERED WATER FOR HUMAN CONSUMPTION Final Report
Courtney A. Metzger, Albert B. Hearld, and Bobby G. Mc Mullen Feb. 1967 49 p refs
(AMRL-TR-66-137; AD-652491) CFSTI: HC $3.00/MF $0.65

Analyses were made of water recovered from human urine and from atmospheric condensate collected during manned tests inside a sealed chamber. Data on more than 200 samples were prepared for comparison with that of distilled water and tap water and with U.S. Public Health Standards for drinking water. Most of the samples were suitable for human consumption. Candidate systems for recovering potable water from urine were evaluated. Thermoelectric, electrodialysis, and vapor compression water reclamation devices were determined to be suitable for use during extended aerospace missions. Author (TAB)

N67-32691# Admiral Corp., Chicago, Ill.
DEVELOPMENT OF A PULSED X-RAY TELEVISION FLUOROSCOPE FOR BIODYNAMIC RESEARCH Final Report, Aug. 1963–May 1966
E. B. Weis, Jr. (AMRL), W. G. Leysath, and K. R. Horning Wright-Patterson AFB, Ohio. AMRL Mar. 1967 50 p refs
(Contract AF 33(615)-1878)
(AMRL-TR-66-189; AD-652851) CFSTI: HC $3.00/MF $0.65

The work presents a logical picture of a biodynamics instrumentation requirement, a design to answer the requirement, testing of the prototype, evaluation of the quality of the prototype, and a discussion of the advantages and limitations of the design. The operational nature of a high-speed X-ray device with certain advantages for biodynamic research is discussed. The final nature of the device is found to have certain advantages over commercially available X-ray units for general medical research purposes as well as for general clinical radiology. Author (TAB)

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-31499# National Institutes of Health, Bethesda, Md. Translating Unit.
A NEW COLOR REACTION FOR THE PYRIDINE RING AND FOR THE PYRIDINE ALKALOIDS
A. A. Shmuk 8 Jun. 1967 2 p refs Transl. into ENGLISH from Priroda (Moscow), v. 22, no. 2, 1940 p 65

A color reaction of the reciprocal effect of pyridine and its derivatives with the bromothiocyanogen reagent and aromatic amines was developed. The reagents needed for the reaction and the procedure for realizing the reaction are described. The reaction was used in the colorimetric quantitative determination of the nicotine and anabasine, and was found to be more accessible than the reaction with cyanogen bromide. N.E.N.

N67-31502# Kansas Univ., Lawrence. Dept. of Chemistry.
PHOTOLYSIS STUDIES UTILIZING RADIOACTIVE TRACERS Final Technical Report, 1 Oct. 1961–30 Sep. 1965
F. S. Rowland [1967] 83 p refs
(Grants AF-AFOSR-62-15; AF-AFOSR-534-64)
(AFOSR-67-1079; AD-652282) CFSTI: HC $3.00/MF $0.65

The objective of the research was the attack on two important photochemical problems through the use of radioactive tracer techniques. These problems are: (1) the reaction of methylene with olefins, utilizing CHT from the photolysis of CHT + CO; and (2) the reactions of energetic hydrogen atoms (2.8 e.v.) with alkanes, using T atoms from the photolysis of TBr. Trace levels in bulk components was utilized. In addition, isotopic differences in the reactions themselves have been evaluated. The most important results of the research have depended heavily on the development of techniques for gas chromatographic separation of isotopic isomers of olefind and alkanes. Author (TAB)

N67-31508# Joint Publications Research Service, Washington, D. C.
ELECTRON SPIN RESONANCE RESEARCH CONDUCTED IN HUNGARY IN THE FIELD OF MACROMOLECULAR CHEMISTRY
Ferenc Tudos 22 May 1967 8 p Transl. into ENGLISH from Kemiai Kozlemen. (Budapest), v. 27, no. 2, 1967 p 227–231
(JPRS-41116; TT-67-31757) CFSTI: $3.00

Effects of X-ray and gamma irradiation on electric conductivity and paramagnetic properties of plastics were studied using a measuring device that determines conductivity and slow dielectric polarization at different temperatures during irradiation. A homodyne-type electron spin resonance (ESR) spectrometer operating on a 3 cm wave band was used to study the role of free radicals. Briefly described are ESR studies of stable free radicals which are also used as inhibitors; reactions between the primary radical formed from the initiator and the typical inhibitors of radical polymerization; intermediate radicals formed as a result of the reaction between polymer radicals and inhibitors; and reactions between certain monomers and inhibitors, leading to thermal radical formation. Other ESR studies concerned electron donor–acceptor complexes and the hot radical effect. ESR techniques were also used to investigate the grafting of styrene to pre-irradiated and peroxidated Teflon and polychlorotrifluoroethylene. The concentration of radicals in the basic polymer and the limitation of grafting were measured as a function of the preliminary dose. Mentioned is also an ESR study of the effect of additives on the concentration of radicals in the polymerization of N-vinyl-carbazol. K.W.

N67-31513# Midwest Research Inst., Kansas City, Mo.
A NEW METHOD OF OBTAINING THE WELL DEPTH FOR WEAK INTERMOLECULAR POTENTIALS Summary Technical Report
Thomas A. Milne and Frank T. Greene 12 Jun. 1967 11 p refs Submitted for publication
(Contract Nonr-3599(00))
(AD-653314) CFSTI: HC $3.00/MF $0.65

A straightforward mass spectrometric determination of the dimerization heat of rare gases is shown to be feasible. A method of data reduction is proposed which appears to yield a depth of the potential well independent of prior choice of the form of the potential function. Errors in the measurements are discussed. Author (TAB)

N67-31558# Los Alamos Scientific Lab., N. Mex.
FURTHER TESTS OF DILUTE SOLUTION EQUATIONS AND THERMODYNAMIC RELATIONSHIPS: THE VAPOR PRESSURE OF CADMIUM OVER LIQUID ALLOYS CONTAINING SMALL AMOUNTS OF LEAD
Harold S. Swofford, Jr. and Guy R. B. Elliott 5 Apr. 1967 24 p refs
(Contract W-7405-ENG-36)
(LA-3657) CFSTI: HC $3.00/MF $0.65

The vapor pressure of cadmium over molten lead–cadmium alloys in the dilute lead range has been measured by the isopiestic balance technique. In the range 0.004 to 0.010 mole fraction lead, the cadmium vapor pressures at 780°K obey the relationship $P_{Cd\ alloyed}/P_{Cd\ pure} = 1-1.63\,N_{Pb}$ when N_{Pb} is the mole fraction of lead in solution. The solvent thus shows strong

negative deviation from Raoult's law in a concentration region where it is conventional to assume, based on thermodynamic arguments, that Raoult's law would be obeyed or at least closely approached. Some of the implications of this result are discussed. At larger lead concentrations an increasing curvature becomes observable, and from 0.015 to 0.032 mole fraction lead the relationship $P_{Cd\ alloyed}/P_{Cd\ pure} = 1-2.04\ N_{Pb}+33.0\ N_{Pb}^2$ is obeyed, the activity becoming positive to Raoult's law at 0.9683 mole fraction cadmium. Author (NSA)

N67-31559# International Union of Pure and Applied Chemistry, Basle (Switzerland). Commission on High Temperatures and Refractories.

BIBLIOGRAPHY ON THE HIGH TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS

L. Brewer (Calif. Univ.), comp. 31 Mar. 1967 13 p refs (Rept.-22) Available from Natl. Bur. of Std., Washington, D. C.

Listed are 59 titles dealing with spectroscopy of interest to high temperature chemistry and 54 titles on the reaction between gases and condensed phases. The works were mainly published during 1966; the exceptions were published during 1964 and 1965. K.W.

N67-31645# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE FELDSPARS PHASE RELATIONS, OPTICAL PROPERTIES, AND GEOLOGICAL DISTRIBUTION [POLEVYE SHPATY FAZOVYE VZAIMOOTNOSHENIYA, OPTICHESKIE SVOISTVA, GEOLOGICHESKOE RASPREDELENIE]

A. S. Marfunin 1966 328 p refs Transl. into ENGLISH from Izd. Akad. Nauk SSSR (Moscow), 1966 Published by Dept. of Interior and NSF *Its* Issue 78 (TT-65-50091) CFSTI: $3.00

The ordering phenomena of feldspars is described on the basis of structural-crystallographic data. A mineral class which constitutes more than one half of the Earth's crust, the feldspars are fully documented in relation to their phase relations, optical properties, and geological distribution. Consideration is given to relationships of structural varieties of feldspars as found in the most important rock types, by means of combined optical and X-ray investigation methods. R.Li.

N67-31659# Technische Hogeschool, Eindhoven (Netherlands).

STRUCTURE ANALYSIS ON STEREOREGULAR POLYMETHYLMETHACRYLATE IN SOLUTIONS [CONFORMATIEONDERZOEK AAN STEREOREGULAIR POLYMETHYLMETHACRYLAAT IN OPLOSSINGEN]

Willem Bonno Van Den Berg (Ph.D. Thesis) [1967] 125 p refs In DUTCH; ENGLISH summary CFSTI: HC $3.00/MF $0.65

Measurements were performed on the stereo isomers of polymethyl methacrylate (PMMA) to establish the molecular shape in solution and to determine if the molecules of vinyl polymers have another conformation than the random coil. PMMA was chosen because its stereo-regular isomers are easy to synthesize and their stereochemical purity can be defined well. In addition to characterization, the following measurements were performed to obtain structural information: light scattering measurements, viscosity measurements in dependence of concentration, structure viscosity at high shear stresses, and measurements of the Weissenberg effect and the spinnability. It was found that compared with syndiotactic molecules, isotactic molecules in solution own a higher Huggins constant and a lower second virial coefficient in addition to being less soluble. The correlation between radius of gyration and average molecular weight seems to be of a greater value for isotactic polymers, which also show a tendency toward network forming. UV spectral analysis established that the isotactic molecules, compared with the syndiotactic, have great conformational regularity in solution. It was concluded that most probably the isotactic PMMA molecules in solution possess the helix conformation, while the syndiotactic molecules appear to have the random coil shape. K.W.

N67-31669# Library of Congress, Washington, D. C. Aerospace Technology Div.

DIFFUSION THEORY OF ADHESION AND ITS APPLICATION TO BONDING OF PLASTICIZED ELASTOMERS

Boris Ofrossimow *In its* Foreign Sci. Bull., Vol. 3, No. 5 May 1967 p 20-30 refs (See N67-31666 18-34)

The diffusion theory of polymer adhesion is briefly reviewed. New direct evidence is provided for the adhesion mechanism of bonding which involves the mutual diffusion of the polymers being bonded. The mechanism of bonding of plasticized elastomers is investigated and discussed on the basis of the diffusion theory of adhesion. Author

N67-31670# Library of Congress, Washington, D. C. Aerospace Technology Div.

RESEARCH PROGRESS ON RARE EARTH ELEMENT CHALCOGENIDES

John G. Kourilo *In its* Foreign Sci. Bull., Vol. 3, No. 5 May 1967 p 31-49 refs (See N67-31666 18-34)

A review was made of the Soviet progress from mid-1965 to mid-1966 in the preparation techniques and in the determination of crystallochemical and physical properties of rare earth chalcogenides. An improvement was noted in the preparation technique of single crystals of neodymium tellurides. The complete phase diagram of the praseodymium-selenium system was established for the first time and the phase diagram of the neodymium-tellurium system was refined. Three new Pr-Se compounds were detected and two of them were obtained in single crystalline form. New crystallochemical data were determined for neodymium selenides, praseodymium, and lanthanum tellurides. n-Type electric conductivity was established for all known neodymium telluries and superconductivity was detected in La_3Te_4. Possible antiferromagnetism was indicated for $PrTe_{1.9}$; magnetic ordering at low temperatures was established in CeS, CeSe, CeTe, NdS, NdSe, NdTe, and PrS. Development of new high temperature semiconductor materials and new ferro- or antiferromagnetic materials appeared to be the purpose of the greatest number of studies reviewed. Author

N67-31677# Library of Congress, Washington, D. C. Aerospace Technology Div.

BIOLOGICALLY ACTIVE ORGANOTIN AND ORGANOLEAD COMPOUNDS AND POLYMERIC MATERIALS

Serge Markov *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 69-87 refs (See N67-31672 18-34)

Research in the Soviet Union on biologically active organotin and organolead low-molecular-weight compounds and polymeric materials has yielded new and effective insecticides, bactericides, fungicides, algicides, zoocides, bactericidal polymers, and promising physiologically active preparations. Polymers that are suitable as alloimplant or radiation-protective materials have also been developed. On a theoretical plane, the research has given some insight in the relationship between the chemical structure of these compounds and their biological activity. Author

N67-31703 Northwestern Univ., Evanston, Ill. Technological Inst.

DIFFUSION STUDIES IN LEAD SULFIDE Final Report, 1 Feb. 1962 -31 Jan. 1967

J. Bruce Wagner, Jr. 31 Jan. 1967 148 p refs (Contract Nonr-1228(24)) (AD-649047) CFSTI: HC $3.00/MF $0.65

The ratio of tracer diffusion coefficients, D sub Pb 210/D sub Bi 210, at 700C is independent of deviations from stoichiometry for undoped lead sulfide single crystals and crystals doped with 4 x 10 to the 18th power and 4 x 10 to the 19th power bismuth atoms and is equal to one. The addition of 4 x 10 to the 18th power atoms of bismuth to lead sulfide does not increase the diffusion coefficients of Pb210 and Bi210 for -6.7 < log p sub S2 < 0.0 at 700C. For log p sub S2 > -3.9 and at 700C the singly ionized cation vacancy is the predominant defect through which Pb210 and Bi210 diffuse and is the majority atomic defect in undoped lead sulfide and lead sulfide doped with 4 x 10 to the 18th power bismuth atoms. The addition of 4 x 10 to the 19th power atoms of bismuth increases the self-diffusion coefficients of Pb210 and Bi210 for -6.7 < log p sub S2 < 0 at 700C. Author (TAB)

N67-31704 Northwestern Univ., Evanston, Ill. Dept. of Materials Science.
DETERMINATION OF THE CHEMICAL DIFFUSION COEFFICIENT OF MANGANOUS OXIDE
J. B. Price and J. B. Wagner, Jr. 14 Jan. 1967 *In its* Diffusion Studies in Lead Sulfide 31 Jan. 1967 15 p refs (See N67-31703 18-06)

Preliminary determinations of the chemical diffusion coefficient were made for mono-crystalline MnO at 1150° and 930°C in the p-region of the MnO phase field and at 1150°, 970° and 847°C in the n-region of the phase field. An electronic conductivity technique was used. Each sample was equilibrated under a given oxygen pressure. The oxygen pressure was then isothermally changed to a new value, and the electronic conductivity of each sample was measured as a function of time until the sample equilibrated with the new oxygen pressure. Author

N67-31705 Northwestern Univ., Evanston, Ill. Dept. of Materials Science.
THE RATE OF REACTION OF SULFUR WITH LEAD
Frank Fradin and J. Bruce Wagner, Jr. 30 Dec. 1965 *In its* Diffusion Studies in Lead Sulfide 31 Jan. 1967 15 p refs (See N67-31703 18-06)

The rate of sulfidation of lead and lead alloyed with small amounts of bismuth, sodium or silver was studied at 250°, 275°, and 300°C. The rates decrease in the order: sodium-doped lead, bismuth-doped or undoped lead, and silver-doped lead. Only the silver-doped lead sulfidized with parabolic kinetics. The remainder sulfidized with linear kinetics because of the cracking of the sulfide layer on the lead. Author

N67-31735 Rockett Propulsion Establishment, Westcott (England).
THE DISSOCIATION ENERGY OF THE N–H BOND IN HYDRAZINE AND RELATED COMPOUNDS
I. P. Fisher Dec. 1965 20 p refs
(RPE-TR-65/II)

There are, currently, two values proposed for the N–H bond dissociation energy in hydrazine. Arguments are presented in favour of the lower value. Bond strengths, heats of formation and ionization potentials of radicals related to the hydrazyl radical are derived. Author

N67-31815 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HETEROCHAIN HIGH-MOLECULAR COMPOUNDS. COLLECTION OF ARTICLES—SELECTED ARTICLES
2 Sep. 1966 25 p refs Transl. into ENGLISH of the book "Geterotsepnyye Vysokomolekulyarnyye Soyedineniya" Moscow, Izd. Nauka, 1963 p 76–80, 134–138
(FTD-HT-66-115; AD-646447)

CONTENTS:

1. PHOSPHORUS CONTAINING POLYESTERS AND POLYAMIDES OF ALIPHATIC SERIES Ye. V. Kuznetsov, R. K. Valedfinov, and G. N. Vershinina p 1–8 refs (See N67-31817 18-06)

2. SYNTHESIS AND INVESTIGATION OF POLYMER PROPERTIES FROM BORON FLUORIDE BISDIAZONIUM–4,4' DIPHENYL A. A. Berlin, B. N. Liogon'kiy, and V. P. Parini p 9–18 refs (See N67-31818 18-06)

N67-31817 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHOSPHORUS CONTAINING POLYESTERS AND POLYAMIDES OF ALIPHATIC SERIES
Ye. V. Kuznetsov, R. K. Valdefinov, and G. M. Vershinina *In its* Heterochain High-Mol. Compds., 2 Sep. 1966 p 1–8 refs (See N67-31816 18-06)

Phosphorus containing polyesters and polyamides of the aliphatic series were obtained on the basis of bis-beta-carboxyethylphosphinic acid which was synthesized by hydrolizing bis-beta-cyanethylphosphine oxide. The noncombustible polyesters and polyamides obtained are capable of fiber and film formation and have a much higher melting point than analogous polymers containing no phosphorus atom. The study shows that the polycondensation reaction of bis-beta-carboxyethylphosphinic acid with glycols and hexamethylmethyldiamine is subject to a second order reaction equation which determines the rate of reaction constants and the activation energy. R.N.A.

N67-31818 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SYNTHESIS AND INVESTIGATION OF POLYMER PROPERTIES FROM BORON FLUORIDE BISDIAZONIUM–4,4' DIPHENYL
A. A. Berlin, B. N. Liogon'kiy, and V. P. Parini *In its* Heterochain High-Mol. Compds., 2 Sep. 1966 p 9–18 refs (See N67-31816 18-06)

Aromatic polymers with an average molecular weight of from 4000 to 4500 were synthesized by reducing boron fluoride of bis-diazotated bensidine with salts of monovalent copper. These polymers, analogous to polymers synthesized from bis-diazonium chloride, contain an azo grouping together with phenyl groups. Results of infrared spectral analyses, viscosimetric measurements, and thermomechanical tests show that these polymers have longer polymeric molecules with a system of conjugated bonds than the polymers synthesized from bis-diazonium chloride, and also give a more intense electron paramagnetic resonance signal and contain a greater static magnetic permeability. The polymers show high thermostability in inert atmospheres up to 500°C. R.N.A.

N67-31894* Joint Publications Research Service, Washington, D. C.
PROCESSES AND APPARATUS OF VACUUM ELECTROTHERMY
23 Jun. 1967 71 p refs Transl. into ENGLISH from Tr. Inst. Met., Akad. Nauk SSSR, Ural'sk Filial (Sverdlovsk), no. 11, 1966 p 1–221
(JPRS-41540; TT-67-32173)

CONTENTS:

1. THE KINETICS OF REDUCING POTASSIUM BY THE VACUUM THERMIC METHOD IN LABORATORY PILOT-PLANT FURNACES A. S. Mikulinskiy and I. Ye. Sipeyko p 1–9 refs (See N67-31895 18-11)

2. INVESTIGATION OF THE CONDITIONS FOR CONDENSATION OF VAPORS OF POTASSIUM AND ACCOMPANYING VAPORS OF ITS CHLORIDE DURING PRODUCTION OF POTASSIUM BY THE VACUUM THERMIC

METHOD I. Ye. Sipeyko and A. S. Mikulinskiy p 9–21 refs (See N67-31896 18-06)

3. ON THE THEORY OF REDUCING CALCIUM OXIDE WITH CARBON G. N. Kozhevnikov p 22–27 refs (See N67-31897 18-06)

4. WAYS OF SIGNIFICANTLY REDUCING COSTS IN THE PRODUCTION OF CALCIUM A. S. Mikulinskiy and V. V. Yefremkin p 28–40 refs (See N67-31898 18-06)

5. REDUCTION OF CALCIUM OXIDE WITH FERROSILICON IN A VACUUM ALONG WITH THE FORMATION OF MOLTEN SLAG A. S. Mikulinskiy and V. A. Kozlov p 41–54 refs (See N67-31899 18-17)

6. CONCERNING THE LOSSES OF REDUCING AGENT IN THE SILICOTHERMIC METHOD OF PRODUCING MAGNESIUM AND CALCIUM A. S. Mikulinskiy and V. A. Kozlov p 55–62 refs (See N67-31900 18-06)

N67-31896# Joint Publications Research Service, Washington, D. C.

INVESTIGATION OF THE CONDITIONS FOR CONDENSATION OF VAPORS OF POTASSIUM AND ACCOMPANYING VAPORS OF ITS CHLORIDE DURING PRODUCTION OF POTASSIUM BY THE VACUUM THERMIC METHOD

I. Ye. Sipeyko and A. S. Mikulinskiy *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 9–21 refs (See N67-31894 18-06)

The experimental procedures for using the carbidothermic method are described for potassium production in small and large laboratories and pilot plant installations. The vapor pressure and temperature for condensation, the potassium chloride sublimate distribution over the condensation zones, and the composition and physical characteristics are described, and the results of the investigation in the pilot plant furnace are discussed. It was concluded that the separate condensation of potassium and potassium chloride vapors in different temperature zones was satisfactorily accomplished in the pilot plant installation. N.E.N.

N67-31897# Joint Publications Research Service, Washington, D. C.

ON THE THEORY OF REDUCING CALCIUM OXIDE WITH CARBON

G. N. Kozhevnikov *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 22–27 refs (See N67-31894 18-06)

The reactions occurring in the Ca–C–O system, based on recent thermodynamic calculations, are discussed. The effects of purity of the condensed phases are analyzed, and the temperature dependence of the gas phase pressure is illustrated. An experiment is described in which calcium oxide was produced by calcining chemically pure limestone at 1000°C for several hours, and it was established that only traces of carbide remain. However, after the temperature was raised to 1300°C, the calcium carbide in the residue increased. N.E.N.

N67-31898# Joint Publications Research Service, Washington, D. C.

WAYS OF SIGNIFICANTLY REDUCING COSTS IN THE PRODUCTION OF CALCIUM

A. S. Mikulinskiy and V. V. Yefremkin *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 28–40 refs (See N67-31894 18-06)

High temperature methods of producing calcium and their relative costs are reviewed. The methods described include: reduction of calcium oxide with aluminum, calcium carbide dissociation, reduction of calcium–silicon with aluminum and iron, electrolysis of fused calcium chloride using a molten copper–calcium cathode, and reducing calcium carbide with ferrosilicon. Furnace design is mentioned. Vaporous calcium used as a reducing agent for refractory metals is discussed, and the specific heats of reaction, temperatures of reaction products, and minimum residual pressures are estimated. It was concluded that the high temperature method of reducing lime with ferrosilicon and calcium–silicon and dissociating the calcium carbide requires low expenditures of raw materials and electric power and is the most promising. N.E.N.

N67-31900# Joint Publications Research Service, Washington, D. C.

CONCERNING THE LOSSES OF REDUCING AGENT IN THE SILICOTHERMIC METHOD OF PRODUCING MAGNESIUM AND CALCIUM

A. S. Mikulinskiy and V. A. Kozlov *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 55–62 refs (See N67-31894 18-06)

A review is presented of the chemical reactions and physical properties of the reduction process emphasizing the reducing agent loss due to volatilization. Tables are included on the equilibrium vapor pressure of SiO and on the variation in the isoberic potential of MgO and CaO reduction by SiO. It was concluded from the discussions that: (1) In the magnesium reduction from magnesite the oxidation of silicon is incomplete. (2) Calcium disilicide and silicon monoxide formation affect the silicon losses in the silicothermic reduction of magnesium from dolomite and calcium from calcium oxide. (3) Increasing the CaO/SiO_2 ratio in the slag, briquetting the charge, and blending the charge reduce the losses. (4) Silicon losses are smaller in a large furnace with a deep bed of charge materials. N.E.N.

N67-31980# Canadian Commercial Corp., Ottawa (Ontario).

ELECTROCHEMICAL STUDIES OF PLATINUM SURFACE OXIDATION IN RELATION TO HYDROCARBON OXIDATION. PART IV: STUDIES WITH C^{14}-LABELLED COMPOUNDS IN RELATION TO CO_2 FORMATION AND SURFACE OXIDATION OF Pt Interim Report, Jun. 1964–Oct. 1966

D. Gilroy, L. Marincic, J. Wojtowicz, and E. J. Rudd (Ottawa Univ.) Oct. 1966 36 p refs

(AD-652680) CFSTI: HC $3.00/MF $0.65

A study was made of adsorption of carbon-containing intermediates in a model Faradaic reaction (that of formate and formic acid) at Pt and of the possible involvement of CO2 or CO3(--) as a chemisorbed species which it may also be necessary to consider in this respect in the hydrocarbon oxidation process. A C14-labelling technique was developed for use under conditions where appreciable Faradaic oxidation currents are passing and the measured extent of adsorption of the ad-species is therefore the steady-state value rather than the equilibrium value except at low anodic Faradaic currents. Author (TAB)

N67-32021# Army Weapons Command, Rock Island, Ill. Research and Engineering Div.

X-RAY SPECTROCHEMICAL METHODS FOR ANALYSIS OF COPPER ALLOYS

L. H. Moorhead and O. J. Uttig Mar. 1967 44 p refs

(RIA-67-849; AD-652733) CFSTI: HC $3.00/MF $0.65

X-ray spectrochemical methods were developed for both solid and solution samples. Solid standards were prepared in an induction furnace or a small arc furnace. The standards were analyzed by wet chemical methods and by X-ray solution techniques. Analytical working curves were prepared for manganese bronzes, aluminum bronzes, and brasses using the Rock Island Arsenal secondary standards and available primary standards. Problems of short time instrumental drift were minimized by alternating samples and standards and averaging results. Problems in long time instrumental drift were solved by applying a mathematical computation method suggested by Loranger. Author (TAB)

N67-32101# Eidgenossische Technische Hochschule, Zurich (Switzerland).
ON REACTION KINETICS OF OXYDO-REDUCTION [ZUR REAKTIONSKINETIK DER OXYDOREDUKTASEN]
August Kaiser (Ph.D. Thesis) 1966 106 p refs In GERMAN
(DISS-3896)

The enzymes, alcohol dehydrogenase (LADH) from horse liver and e-oxyreductase from Mucor javanicus (MOR) were analyzed for their reaction kinetics by forming several theoretical molecular models. Each model consisted of a number of elementary steps that expressed specific kinetic velocity by individual differential equations. Statistical regression methods were then used to eliminate those models that did not comply with experimental results. It was found that alcohol hydrogenase probably possessed a one track mechanism in which the final separation of the co-enzyme at the end of the reaction regulates its kinetic velocity whereas hydrogen transfer is relatively rapid. Hydrogen transfer velocity in e-oxyreductase was regulated by the reaction steps between cyclohexanol and the oxydated co-enzyme; associative and dissociative steps remained in equilibrium. Transl. by G.G.

N67-32120# Technische Hogeschool, Eindhoven (Netherlands).
EVOLUTION OF CHLORIN AT GRAPHITE ELECTRODES [VORMING VAN CHLOOR AAN ELEKTRODEN VAN GRAFIET]
Leonard Johannes Joseph Janssen (Ph.D. Thesis) [1967] 179 p refs In DUTCH; ENGLISH summary
CFSTI: HC $3.00/MF $0.65

Investigated was the mechanism of chlorine evolution at a graphite anode both during the electrolysis of an aqueous NaCl solution and after switching off the polarizing current. In addition, it was sought to establish the effect of anodic polarization on the structure of the surface of a graphite anode and to determine the chlorine uptake. For a porous electrode, theory and experimental results are compared regarding current density, potential and time during galvanostatic charging and during potentiostatic application of a potential pulse, and the impedance and frequency when using alternating current. The oxidation process causing surface roughness is examined. Molecular chlorine evolution during electrolysis was determined for an aged electrode covered with a layer of anodic oxide and for a new electrode covered with a stable layer of oxide. Open circuit chlorine evolution was theoretically deduced and numerically calculated based on the Heyrowsky reaction and Fick's diffusion equation. K.W.

N67-32266# Technische Hogeschool, Eindhoven (Netherlands).
THE CHEMISTRY AND LUMINESCENCE OF ANTIMONY-CONTAINING CALCIUM CHLORAPATITE
Age Hylke Hoekstra (Ph.D. Thesis) 6 Jun. 1967 92 p refs
CFSTI: HC $3.00/MF $0.65

The properties of calcium chlorapatite, both pure and antimony-activated, and of antimony-containing calcium phosphates are dealt with. This investigation was started in order to achieve a better insight into the complex reactions which occur during the preparation of calcium–halophosphate phosphors. A short introduction deals with the problems which arise in the preparation of this phosphor. The literature on compounds possessing the apatite crystal structure is reviewed and a survey of the materials used and the methods employed is given. Unactivated calcium chlorapatite was prepared. This apatite is readily pyrohydrolysed to calcium hydroxyapatite. When the pyrohydrolysis occurs in the presence of $Ca_2P_2O_7$ it is followed by a decomposition of the apatite to orthophosphate. This reaction results in a distribution of calcium and phosphate between two contaminating phosphate phases, namely $Ca_2P_2O_7$ and $Ca_3(PO_4)_2$ when calcium chlorapatite is prepared with an excess of phosphate. Both the pyrohydrolysis and the decomposition of chlorapatite are found to be reversible reactions and a study of the first reaction leads to an improved method of preparing pure calcium chlorapatite. In spite of a difference in structure between calcium chlorapatite and calcium hydroxyapatite there is a continuous range of solid solutions between these apatites which is attributed to the substitution of oxygen-vacancy pairs for either chlorine or hydroxyl ions. Author

N67-32267# Eidgenossische Technische Hochschule, Zürich (Switzerland).
ELECTROCHEMICAL STUDY OF ANODIC OXIDE LAYERS OF TANTALUM
Aladar Tvarusko (Ph.D. Thesis) 1966 97 p refs Supported in part by CIBA, Ltd., Basel
(DISS-3879) CFSTI: HC $3.00/MF $0.65

An electrochemical study was made of the anodic formation of tantalum oxide used in electrolytic capacitors. The work focused on the initial stages of the anodization, i.e. on very thin layers and on low currents. The experiments were carried out under galvanostatic (constant-current) or constant-voltage conditions, with both the steady and nonsteady states investigated. A summary of significant results and conclusions is included. C.T.C.

N67-32278*# Rice Univ., Houston, Tex. Dept. of Chemistry.
THE CRYSTAL STRUCTURE OF DIPOTASSIUM TETRANITROETHIDE
Maurice Dyke and Ronald L. Sass [1967] 10 p refs
(Grant NsG-6)
(NASA-CR-86980) CFSTI: HC $3.00/MF $0.65 CSCL 07C

The structure of dipotassium tetranitroethide has been determined by single crystal X-ray diffraction techniques. The compound crystallizes in the centro-symmetric space group C2/c with cell constants of a = 13.03 A, b = 7.56A, c = 13.55A, and β = 140.87°. Each unit cell contains four molecules, with the anions centered on two-fold rotation axes. Atomic and thermal vibration parameters were refined by isotropic least squares method to give a final structure with an R value of 12.3%. The configuration of each carbon atom and its three substituents is planar within experimental error. There is a twisting of the nitrogen atoms about the C–C molecular axis to produce an angle of 83.1° between the N–C–N planes in the tetranitroethide anion. The C–C bond distance is 1.43 A. Author

N67-32280*# Gillette Research Inst., Inc., Washington, D. C.
EXPLORATORY STUDIES OF CONTACT ANGLE HYSTERESIS, WETTING OF SOLIDIFIED RARE GASES AND SURFACE PROPERTIES OF MERCURY Final Report
Anthony M. Schwartz, Alfred H. Ellison, John D. Galligan, and Charles A. Rader 19 May 1967 54 p refs
(Contract NAS3-8909)
(NASA-CR-72269) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Three new areas of fundamental surface chemistry were explored in this work. These were new approaches to contact angle hysteresis, the wetting of solidified rare gas surfaces, and the effect of trace metal impurities on the surface properties of mercury. In the contact angle hysteresis work, systems were studied in which surface roughness and/or chemical heterogeneity were eliminated or controlled so as to obtain evidence for "intrinsic" hysteresis. In the second phase of the work, Argon, Krypton, and Xenon were condensed as solid films on metal planchets at suitable temperatures and the spreading of suitable liquids on the surfaces observed. In the third phase of the work, the effect of trace impurities on the surface properties of mercury was observed by changes in the appearance, wetting by liquids, and surface potential. Author

N67-32289*# Melpar, Inc., Falls Church, Va.
STUDIES IN COMETARY ASTROPHYSICS Final Report, 19 May 1965–18 May 1967
Vincent J. De Carlo 18 May 1967 76 p refs
(Contract NASw-1417)
(NASA-CR-86551) CFSTI: HC $3.00/MF $0.65 CSCL 07D

CONTENTS:

1. VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. VIII: PHOTOLYSIS OF HYDRAZINE-^{15}N IN THE PRESENCE OF ^{14}NO AT 1470 Å L. J. Stief and V. J. De Carlo 17 p refs (See N67-32290 18-06)

2. VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. IX. PRIMARY AND CHAIN PROCESSES IN THE PHOTOLYSIS OF HYDROGEN PEROXIDE L. J. Stief and V. J. De Carlo 21 p refs (See N67-32291 18-06)

3. VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. X. PRIMARY PROCESSES IN THE PHOTOLYSIS OF METHYLACETYLENE AT 1470 AND 1236 Å L. J. Stief and V. J. De Carlo 12 p refs (See N67-32292 18-06)

4. THE PRODUCTION OF SINGLET C_2 IN SHOCK-HEATED CYANOGEN R. J. Fallon and M. P. R. Thomsen 5 p refs (See N67-32293 18-06)

5. ELECTRON-IMPACT EMISSION SPECTRA. I. METHANE V. J. De Carlo and M. J. Donohoe 5 p refs (See N67-32294 18-06)

6. ELECTRON-IMPACT EMISSION SPECTRA. II. ACETYLENE V. J. De Carlo and M. J. Donohoe 5 p refs (See N67-32295 18-06)

N67-32290*# Melpar, Inc., Falls Church, Va. Research Div.
VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. VII: PHOTOLYSIS OF HYDRAZINE-^{15}N IN THE PRESENCE OF ^{14}NO AT 1470 Å
L. J. Stief and Vincent J. De Carlo *In its* Studies in Cometary Astrophys. 18 May 1967 17 p refs (See N67-32289 18-06)

The relative contributions of direct molecular elimination and radical disproportionation reactions to the formation of non-randomized nitrogen in the photolysis of hydrazine and hydrazine-^{15}N have been determined by examining the production of $^{30}N_2$ in the photolysis of hydrazine-^{15}N at 1470 Å in the presence of ^{14}NO. The limiting value of the ratio $H_2/^{30}N_2$ is close to two and suggests that the mechanism of the molecular elimination processes is best represented by the sequence $N_2H_4 \rightarrow N_2H_2 + H_2$. $N_2H_2 \rightarrow N_2 + H_2$. The ratio of disproportionation to combination of radicals in the system (N_2H_3 and NH_2) is approximately five. The formation of $^{29}N_2$ is attributed to the reaction of $^{15}NH_2$ with ^{14}NO while the formation of $^{29}N_2$ is discussed in terms of the reaction of atomic hydrogen with ^{14}NO. Author

N67-32291*# Melpar, Inc., Falls Church, Va. Research Div.
VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. IX: PRIMARY AND CHAIN PROCESSES IN THE PHOTOLYSIS OF HYDROGEN PEROXIDE
L. J. Stief and Vincent J. De Carlo *In its* Studies in Cometary Astrophys. 18 May 1967 21 p refs (See N67-32289 18-06)

Evidence is presented for the occurrence of primary processes leading to the formation of both atomic and molecular hydrogen in the photolysis of H_2O_2 at 1236 Å. Formation of OH in a primary process probably occurs as well. The latter is apparently the sole process required to explain the results at 1470 and 2537 Å. Processes leading to the formation of $O(^1D)$ account for less than 1% of the photochemical decomposition. Chain processes leading to the formation of O_3 but not H_2 occur at 1236 Å. The possibilities considered are a free radical chain and an energy chain. In spite of some uncertainties, the results are more consistent with the occurrence of an energy chain involving ground-state atomic oxygen and vibrationally excited molecular oxygen. Emission of the OH $A^2\Sigma^+ \rightarrow X^2\pi(0,0)$ band at 3064 Å was observed during photolysis of H_2O_2 at 1236 and 1470 Å. Author

N67-32292*# Melpar, Inc., Falls Church, Va. Research Div.
VACUUM-ULTRAVIOLET PHOTOCHEMISTRY. X: PRIMARY PROCESSES IN THE PHOTOLYSIS OF METHYLACETYLENE AT 1470 AND 1236Å
L. J. Stief and Vincent J. De Carlo *In its* Studies in Cometary Astrophys. 18 May 1967 12 p refs (See N67-32289 18-06)

Molecular elimination of hydrogen occurs in the photolysis of methylacetylene at both 1470 and 1236 Å. This is the sole source of H_2 at 1236 Å, and photolysis of $CD_3C{\equiv}CH$ yields equal amounts D_2 and HD. Evidence for the process $CD_3C{\equiv}CH \rightarrow D_2 + C_3HD^*$, $C_3HD^* \rightarrow C_3 + HD$ is discussed. Atomic hydrogen accounts for 40% of the H_2 formed at 1470 Å. From a study of photolysis of $CD_3C{\equiv}CH$, it is concluded that elimination of paraffinic D is twice as probable as elimination of acetylenic H. Acetylene formed in the photolysis of $CD_3C{\equiv}CH$ at 1470 Å is 90% C_2H_2 and probably arises from formation of the C_2H radical followed by abstraction of H. At 1236 Å, molecular elimination of C_2H_2 may be occurring. Author

N67-32293*# Melpar, Inc., Falls Church, Va. Research Div.
THE PRODUCTION OF SINGLET C_2 IN SHOCK-HEATED CYANOGEN
R. J. Fallon and M. P. R. Thomsen *In its* Studies in Cometary Astrophys. 18 May 1967 5 p refs (See N67-32289 18-06)

Absorption measurements from the $b^1\pi_u$ state of C_2 at 385 Å behind the incident shock front in cyanogen-argon mixtures were spectrometrically recorded at initial pressures of 17 torr of gas mixture. Absorption rose sharply after passage of the shock front and then leveled off to a plateau. The plateau values of the measured absorptions for different concentrations were used to calculate the temperatures under the assumption that equilibrium attained behind the incident shock in the presence of: C_2N_2, CN, Ar, C_2, C_3, N_2, N, and C. The rapid rise of absorption at the shock front and the large levels of absorption observed are attributed to the production of singlet C_2 from the reaction of CN radicals. G.G.

N67-32294*# Melpar, Inc., Falls Church, Va. Research Div.
ELECTRON-IMPACT EMISSION SPECTRA. I: METHANE
Vincent J. deCarlo and M. J. Donohoe *In its* Studies in Cometary Astrophys. 18 May 1967 5 p refs (See N67-32289 18-06)

Electron optical spectra recorded photographically during bombardment of CH_4 with 100 eV electrons are summarized. Emission lines of CH and atomic hydrogen were observed; the intensity of the Ch 4312 Å emission was several times that of the Ch 3872 Å emission. C_3 and CH^+ could not definitely be identified in the CH_4 emission spectra. G.G.

N67-32295*# Melpar, Inc., Falls Church, Va. Research Div.
ELECTRON-IMPACT EMISSION SPECTRA. II: ACETYLENE
Vincent J. deCarlo and M. J. Donohoe *In its* Studies in Cometary Astrophys. 18 May 1967 5 p refs (See N67-32289 18-06)

Photographically recorded electron impact emission spectra of acetylene during bombardment with 100 eV electrons in a vacuum contained emission lines of C_3, HC, and atomic hydrogen. The intensity of the CH 4312 Å emission was several times that of the CH 3872 Å emission. The high resolution photoelectric recordings confirmed a non-equilibrium population of vibrational levels with a marked dominance of intense transitions from upper vibrational levels of the $A^3\pi$ state. G.G.

N67-32378* National Bureau of Standards, Washington, D. C.
ELECTROCHEMICAL DATA. PART VII: ELECTROLYTIC CONDUCTIVITY OF AQUEOUS SOLUTIONS OF HYDROBROMIC ACID Quarterly Report, 1 Mar.-30 Jun. 1967
Harold J. DeWane and Walter J. Hamer 7 Jul. 1967 9 p refs
(NASA Order R-09-022-029)
(NASA-CR-86668; NBS-9573, Pt. VII) CSCL 07B

The data on the electrolytic conductance of hydrobromic acid were studied and are reported in full. Tables are presented which contain: (1) the equivalent conductance at rounded concentrations in absolute mhos at 25°C; (2) the equivalent conductance at rounded concentrations from -20° to 50°C; and (3) the interpolation

equations, constants, and coefficients used to compute the values of conductance. Presented are also the standard deviations of the least square fits used to derive the equations for the various concentration ranges at the given temperatures. The two interpolation equations were obtained by fitting the data at 0, 5, 15, 25, 35, 45, and 55°C. K.W.

N67-32381# Picatinny Arsenal, Dover, N. J.
ENCYCLOPEDIA OF EXPLOSIVES AND RELATED ITEMS, VOLUME 3
Basil T. Fedoroff and Oliver E. Sheffield 1966 558 p refs
(PA-TR-2700, Vol. 3; AD-653029) CFSTI: HC $3.00/MF $0.65

This volume contains entries Chlorides through Detonating relays. Each entry is supported by references to the appropriate source literature. A cumulative index of items discussed in Vols. 1, 2, and 3 is included. TAB

N67-32400* Rice Univ., Houston, Tex. Dept. of Chemistry.
THE CRYSTAL STRUCTURE OF DIBENZOTHIOPHENE SULFONE
Louis R. Kronfeld and Ronald L. Sass [1967] 5 p refs
(Grants NSG-6; USPH FR-00254)
(NASA-CR-88911) CSCL 20B

The crystal and molecular structures of dibenzothiophene sulfone were determined to assess the effect of the sulfone group on the molecular dimensions, and to compare this effect with that observed in similar compounds. The experimental techniques are described. The final atomic parameters are tabulated, and the bond lengths and angles calculated from these parameters are depicted. On the basis of the errors listed in the table, the largest error in a bond length is 0.02 Å; the average error is 0.017 Å. The sulfur carbon bond distance was found to be in good agreement with those found in β isoprene sulfone and cis-2-butene episulfone. The sulfur oxygen bond distance of 1.49 Å is in good agreement with the value predicted from the sum of the packing double bond covalent radii but is about 0.05 Å longer than that observed in other sulfones. In the remainder of the structure, the bond distances and angles are considered comparable to the equivalent values found for fluorene. M.G.J.

N67-32499# Picatinny Arsenal, Dover, N. J. Explosives Lab.
THE WATER ADSORPTION PROPERTIES OF THE POLYMORPHS OF HMX: THE THERMODYNAMICS OF WATER INTERACTION WITH GROUND AND UNGROUND BETA-HMX
Thomas C. Castorina and Jerome Haberman May 1967 39 p refs
(PA-TR-3555; AD-653027) CFSTI: HC $3.00/MF $0.65

Water adsorption isotherms were measured for the polymorphs of octahydro-1,3,5,7-tetranitro-s-tetrazine (HMX). Water is found to sorb into the crystal structure in the order, gamma-HMX > alpha-HMX, and not at all into beta-HMX. The thermodynamics of water interaction with the surface of beta-HMX was studied as a function of grinding action. Grinding reduces the free surface energy of beta-HMX from 25 to 5 ergs/sq cm, and increases the hydrophobic character of the surface by a factor of 12. The calculated thermodynamic functions support the concept of adsorption of water in clusters on both ground and unground beta-HMX surfaces. The integral heat of water adsorption increases with increasing hydrophobicity. This is attributed to unhindered dipole interaction of water with the more isolated active sites of like charges. Accordingly, water is shown to become less entropic as the hydrophobicity is increased. Author (TAB)

N67-32528# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
THERMOGRAVIMETRY OF PHENOL-FORMALDEHYDE POLYCONDENSATES. PART II: EMPIRICAL KINETIC PARAMETERS Technical Report, May 1965–Sep. 1966
R. W. Farmer Mar. 1967 93 p refs
(AFML-TR-65-246; Pt. II; AD-652844) CFSTI: HC $3.00/MF $0.65

Empirical kinetic parameters for phenol-formaldehyde polycondensate materials were surveyed for general application to Air Force interests. The ranges of n, A, E for the empirical kinetic model -(dw/dt) = (w to the nth) A exp (-E/RT) were n = 0-5, A = 0.2 to 1.7 x 10 to the 16th power 1/min, E = 3.7-72kcal/mole, where w is normalized weight, t is time, R is gas constant, T is temperature. The mass spectrometry and thermogravimetry thermal analysis methods used both constant heating rate and isothermal approaches. Reexamination of data with a new computer program gave reduced variations: n = 1.56 plus or minus 0.07, A = 60.9 plus or minus 41.4, E = 10.38 plus or minus 1.20. The scopes of the comprehensive survey and descriptive thermogravimetry computer analysis were: (22 constant rate + 3 isothermal) vs 6 constant rate experiments by 8 vs 3 investigators using (5 cured + 7 vitreous fiber reinforced) vs 4 cured polycondensates. Parameter inconsistencies for the survey were partially associated with an atypical polycondensate, laminate and polycondensate particle or laminate powder samples, or a reduced pressure atmosphere. Calculated parameters apparently dependent upon the two latter aspects were not averaged with other values. Small curve-fitting and other errors potentially enhance further disagreement as they often gave large parameter variations. Author (TAB)

N67-32530*# Melpar, Inc., Falls Church, Va.
DISPERSION CHROMIUM PRODUCT Summary Report
M. L. Gimpel and N. Fuschillo Mar. 1967 27 p ref
(Contract NAS3-7608)
(NASA-CR-54612; Rept.-5360) CFSTI: HC $3.00/MF $0.65 CSCL 07B

Two methods of producing dispersion chromium alloy product were investigated. First, magnesia (MgO) was coated with chromium by chemical vapor deposition from dicumene chromium in a fluidized bed. This method produced high carbon chromium product. The carbon content varied from 0.3 percent to as high as 6.0 weight percent. Second, MgO particles were coated with chromium chloride hexahydrate ($[Cr(H_2O)_6]Cl_3$) by evaporating the dryness of suspension of the MgO particles in solution with chromium chloride hexahydrate. The water of hydration was driven off under a chlorine-rich atmosphere. The composite of chromium chloride ($CrCl_3$) and MgO was then reduced under a dry hydrogen atmosphere. Heating of a pressed sample of the composite at 2400°F (1316°C) caused the MgO particles to combine with the chromium oxide present to form a spinel. Author

N67-32535# Naval Research Lab., Washington, D. C.
A REVIEW OF GAS CHROMATOGRAPHIC-MASS SPECTROMETRIC METHODS OF ANALYSIS Interim Report
F. E. Saalfeld 23 Mar. 1967 22 p refs
(NRL-6525; AD-652823) CFSTI: HC $3.00/MF $0.65

A literature survey of the gas chromatographic-mass spectrometric methods of analysis was made which provides a comprehensive review of the past and present research efforts on the identification of gas chromatograph effluents with a mass spectrometer. The various types of instrumentation employed are described briefly, and critical assessments are made of the various techniques for tandem operation of a gas chromatograph and a mass spectrometer. Author (TAB)

N67-32541# Pennsylvania State Univ., University Park. Combustion Lab.
THE CARBON–OXYGEN REACTION—AN EXPERIMENTAL STUDY OF THE OXIDATION OF SUSPENDED CARBON SPHERES
R. H. Essenhigh and R. W. Froberg Jun. 1967 241 p refs
(Contract Nonr-656(29))

(FS87-2(U); AD-852933) CFSTI: HC $3.00/MF $0.65

Analysis of the carbon-oxygen reaction, at normal pressures, with the use of simultaneous size and weight measurements on single spheres, has substantiated the three zone theory for solid-gas reactions. Experimental results have shown that the true chemical reaction is of zero order with an apparent activation energy of 45 kcal/mole. By combining a zero order, chemical reaction, rate expression with diffusion expressions, it was found that over the temperature range investigated in this study, the overall reaction rate may be described by a single rate expression. Author (TAB)

N67-32589# Copenhagen Univ. (Denmark). H. C. Orsted Institut.
THEORY OF CHEMICAL KINETICS II
Thor A. Bak, Edward R. Fisher, and Carl Nyeland 1 Dec. 1966 69 p refs
(Contract AF 61(052)-697)
(ARL-67-0061; AD-650313)

CONTENTS:

1. THE CONCEPT OF DIFFUSION IN CHEMICAL KINETICS T. A. Bak and E. R. Fisher p 2–27 refs (See N67-32590 18-06)

2. VIBRATIONAL RELAXATION OF DIATOMIC MOLECULES C. Nyeland p 28–33 refs (See N67-32591 18-06)

3. ROTATIONAL RELAXATION OF HOMONUCLEAR DIATOMIC MOLECULES C. Nyeland p 34–47 refs (See N67-32592 18-06)

4. THE RELAXATION AND DISSOCIATION OF SMALL MOLECULES T. A. Bak and E. R. Fisher p 48–62 refs (See N67-32593 18-06)

N67-32590# Copenhagen Univ. (Denmark). H. C. Orsted Institut.
THE CONCEPT OF DIFFUSION IN CHEMICAL KINETICS
Thor A. Bak and Edward R. Fisher *In its* Theory of Chem. Kinet. II 1 Dec. 1966 p 2–27 refs (See N67-32589 18-06)

The diffusion equation and its applications, diffusion-controlled reactions, stepwise activation as a diffusion process, and related theory are discussed in a general survey of the use of the diffusion concept in chemical kinetics. Diffusion is considered in connection with motion in phase space, energy space, or along a reaction coordinate that formally resembles a diffusive motion. The relationship between diffusion in phase space, as described by the Fokker–Planck equation, and diffusion in the ordinary sense is considered; and the generalization of diffusion-like equations is discussed. M.W.R.

N67-32591# Copenhagen Univ. (Denmark). H. C. Orsted Institut.
VIBRATIONAL RELAXATION OF DIATOMIC MOLECULES
Carl Nyeland *In its* Theory of Chem. Kinet. II 1 Dec. 1966 p 28–33 refs (See N67-32589 18-06)

Methods of calculating the probability of energy transfer in a colinear collision between a diatomic molecule and an atom are noted; and an impact parameter approximation that uses a repulsive potential and gives the probability vibrational excitation from ground to first excited level treats the molecule as an harmonic oscillator. Relaxation time is given by three parameters that characterize the potential. A comparison between calculated and experimental results for vibrational relaxation is graphed. M.W.R.

N67-32592# Copenhagen Univ. (Denmark). H. C. Orsted Institut.
ROTATIONAL RELAXATION OF HOMONUCLEAR DIATOMIC MOLECULES
Carl Nyeland *In its* Theory of Chem. Kinet. II 1 Dec. 1966 p 34–47 refs (See N67-32589 18-06)

The impact parameter instead of the scattering angle is taken as the integrational variable in an expression derived for the rotational relaxation of homonuclear diatomic molecules; and it is assumed that the molecules rotate in the same plane during collisions. The intermolecular potential used is Parker's modification of the Morse potential, with the molecular orientations taken into account only in the repulsive part. Collision dynamics and equations and relaxation time are discussed. The equivalent collision number is found to be independent of temperature in these calculations. M.W.R.

N67-32593# Copenhagen Univ. (Denmark). H. C. Orsted Institut.
THE RELAXATION AND DISSOCIATION OF SMALL MOLECULES
Thor A. Bak and Edward R. Fisher *In its* Theory of Chem. Kinet. II 1 Dec. 1966 p 48–62 refs (See N67-32589 18-06)

A one-dimensional quantum mechanical model for the dissociation of a diatomic molecule is considered for the calculation of transition probabilities. The process is treated as a random walk on energy levels of an unperturbed oscillator. To determine the rate of dissociation of the diatomic molecule, the probability per second of the oscillator going from one state to another is found; and the rate constant for dissociation is calculated by the method of Bak and Lebowitz. The same activation in the pre-exponential factor is found as in stepwise activation theory. It is noted that predicted rate constants are often too low. M.W.R.

N67-32657# American Cyanamid Co., Stamford, Conn.
THE RELATIONSHIPS BETWEEN POLYMERS AND GLASS TRANSITION TEMPERATURES Final Report, Apr. 1965–Sep. 1966
O. G. Lewis, and L. V. Gallacher Sep. 1966 34 p refs
(Contract AF 33(657)-11224)
(AFML-TR-65-231, Pt. 3; AD-652218) CFSTI: HC $3.00/MF $0.65

The Gibbs-DiMarzio theory of the glass transition in polymers is formulated in such a way that interdependent rotations may be taken into account. Using an empirically estimated value of 0.025 for the free volume fraction at the transition temperature, the Gibbs-DiMarzio theory was fitted to empirically estimated transition temperatures for the n-alkanes, hexane to eicosane. A good fit was obtained with Epsilon-1 = 765 cal/mole for the energy difference between trans and gauche states, and gauche rotations of opposite sign excluded. The Adam-Gibbs theory of relaxation processes links the viscosity or relaxation time of a polymer to an energy barrier independent of temperature, and an independently rearranging region containing z^* segments, where z^* varies inversely with temperature. Values of z^* calculated from the viscosity data, assuming a minimum value of k ln 2 for the configurational entropy of the critical region, were unreasonably small: one to four segments. A theory is presented by means of which z^* may be calculated from (d ln tau/dP) sub T, avoiding the need for the k ln 2 assumption. The average number of backbone bonds in a single chain through the critical region may be calculated. Chains were generated on a diamond lattice using a Monte Carlo technique, and the computed chain lengths for the three polymers ranged from 10 to 17. Author (TAB)

N67-32664# Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research.
THE DIELECTRIC RELAXATION SPECTRA OF WATER, ICE, AND AQUEOUS SOLUTIONS AND THEIR INTERPRETATION. I. CRITICAL SURVEY OF THE STATUS QUO FOR WATER. II. TENTATIVE INTERPRETATION OF THE RELAXATION SPECTRUM OF WATER IN THE TIME AND FREQUENCY DOMAIN
Arthur R. Von Hippel Apr. 1967 42 p refs
(Contract N00014-67-A-0204-0003)
(TR-1; TR-2; AD-651964) CFSTI: HC $3.00/MF $0.65

On the basis of the presently available evidence, the following picture emerges: Quantum jumps induced by thermal phonon excitation in the near infrared disconnect water dipoles sufficiently from their surroundings to allow reorientation of these dipoles and a subsequent reorganization of their near-surroundings. In an

applied electric field, these jumps can be measured as polarization spike signals in the time domain. The statistical correlation time between consecutive jumps of the same water molecule determines the relaxation time in the frequency domain. With increasing temperature the statistical average of the required activation energy moves from the intramolecular into the intermolecular region, and the effect of deuterium substitution on vibration frequency and time consequently falls. Infrared excitation and microwave relaxation spectrum are coupled in the frequency domain with opposite trends: motion of the excitation spectrum toward higher frequencies moves the relaxation spectrum toward lower frequencies and vice versa. Author (TAB)

N67-32889# Navy Electronics Lab., San Diego, Calif.
DIELECTRIC CONSTANT OF WATER AND SUPERCOOLED WATER: EXPERIMENTAL DETERMINATIONS
E. W. Rusche, Jr. 1 Feb. 1967 88 p refs
(NEL-1434; AD-653061) CFSTI: HC $3.00/MF $0.65

The static dielectric constant of liquid water, epsilon-H2O, was measured at 59 temperatures over the range -5.13 to 25.08C. Values of epsilon-H2O were obtained with greater accuracy than has been achieved previously. No abrupt changes occurred in the dielectric constant over the temperature range studied. The results were used in an examination of two well known theories of the molecular structure of water. The experimental results are accurately described by the equation epsilon-H2O = 88.083 - 0.4042T + (0.00092)(T sq), where T is temperature in degrees centigrade. Author (TAB)

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-31819*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
THE ADMITTANCE OF THE INFINITE CYLINDRICAL ANTENNA IN A LOSSY, ISOTROPIC, COMPRESSIBLE PLASMA
Edmund K. Miller Mar. 1967 88 p refs
(Contract NASr-54(05))
(NASA-CR-86619; Rept.-05627-10-S) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Numerical values are presented for the admittance of an infinite cylindrical antenna excited at a circumferential gap of finite thickness and immersed in a lossy, isotropic, compressible plasma. The formulation uses the linearized hydrodynamic equations for the electrons (ion motion is neglected) together with Maxwell's equations. A free-space layer of finite, variable thickness (the vacuum sheath) is used to approximate the positive ion sheath which forms about a body at floating potential in a warm plasma. The antenna admittance is obtained by direct numerical integration of the Fourier integral for the antenna current, and is presented for plasma parameter values typical of the E-region of the ionosphere. Results show for the parameter range investigated that above the plasma frequency, the electron temperature, electron collisions and the sheath have relatively little influence on the admittance. Below the plasma frequency, the admittance is very dependent upon these parameters. A rather marked maximum in both the conductance and susceptance is found at about half the plasma frequency, which is not present when the sheath thickness and electron temperature are both zero. Of particular interest, is the large increase which may be exhibited by the antenna conductance below the plasma frequency because of the finite electron temperature compared with the zero temperature conductance, for a given value of collision frequency. Author

N67-31521* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPLICATIONS TECHNOLOGY SATELLITE TECHNICAL DATA REPORT, VOLUME III
5 Jul. 1967 801 p refs
(NASA-TM-X-60071) CSCL 17B

Satellite supported airborne communications and various satellite borne experiments conducted with the ATS-1 (B) and ATS-2 (A) are reported. These include meteorological, nutation sensor, environmental measurements, ionospheric, and short term frequency stability of submultiplex tone experiments. Included are summaries of maneuvers commanded and executed on the spacecraft from transfer orbit injection to on-station insertion. C.T.C.

N67-31648 Lockheed Missiles and Space Co., Palo Alto, Calif.
LONG-RANGE, MULTICHANNEL SPACE, I
I. Bogachev, V. Dudnikov, K. Ogorodnikov, and V. Rychka [1967] 7 p Transl. into ENGLISH from Aviats. i Kosmonavt. (Moscow), no. 5, 1967 p 10–14

The Molniia-1 satellite communication system and radio transmission equipment are described. The satellite communication line required for long range, multichannel space requirements consists of a relay station raised to high altitude by means of the satellite, and special ground stations with radio engineering equipment coupled by connecting lines to the nearest ground communication centers. The Molniia-1 system uses a transponder radio station mounted on a satellite injected into a high elliptical orbit with apogee over the Northern hemisphere as the relay for the communication signals. The orbit parameters for the satellite are listed. A block diagram of the Molniia-1 long-range radio communication line is included. R.U.

N67-31840*# Lockheed Missiles and Space Co., Sunnyvale, Calif.
PCM TELEMETRY DATA COMPRESSION STUDY, PHASE II Final Report, 25 Aug. 1965–25 Dec. 1966
T. Bjorn, Jr., W. J. Friccero, and J. E. Medlin Jan. 1967 410 p refs
(Contract NAS5-9729)
(NASA-CR-85894; M-62-66-8) CSCL 17B

The objective of this study was to investigate ways to improve the utilization efficiency of NASA/GSFC PCM telemetry links through data compression. The study was divided into two phases. Phase I included a literature search and subsequent evaluation of known data compression techniques and a study of time and channel identification. Phase II extended the data compression technique evaluation of Phase I, investigated transmission link noise effects, analyzed the impact of compressed data on computer operations, and performed a conceptual design of a ground-based data compression and reconstruction system. This report describes the work performed during Phase II of the study. Author

N67-31883*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPLICATIONS TECHNOLOGY SATELLITE TECHNICAL DATA REPORT, VOLUME II
5 Jul. 1967 1097 p refs
(NASA-TM-X-60070) CSCL 17B

Developments in a nutation sensor experiment, ground system performance, spacecraft systems, and various other experiments to be performed on the ATS-1 (B) satellite are reported. In the nutation experiment consideration is given to the problem of measuring the force-free motion of a spin stabilized satellite subjected

to impulsive torques. The ground system performance area covers descriptions, functions, capabilities, and parameters of the various facilities. Developments are reported for the following spacecraft systems: power, telemetry, command, reaction control, thermal control, and microwave. Accomplishments in the design of microwave and VHF communications, meteorology, nutation sensor, environmental measurements, and ionospheric experiments are included. C.T.C.

N67-32023# Institute for Defense Analyses, Arlington, Va. Research and Engineering Support Div.
RESOLUTION OF MULTIPLE TARGETS IN CLUTTER Research Paper, 1964
Donald Richman Apr. 1967 87 p refs Revised
(Contract ARPA SD-50)
(IDA/HQ-67-6117; P-158; AD-652578) CFSTI: HC $3.00/MF $0.65

The paper deals with the problem of waveform design for multiple target resolution. The objective of the paper is not to offer solutions but to illuminate boundaries of validity of present concepts and indicate areas where basic analytical tools--potentially available and necessary--do not exist as yet. TAB

N67-32024*# Communications Research Labs., Santa Ana, Calif.
STADAN STUDY. FUNDAMENTAL SENSITIVITY LIMITS DUE TO PROPAGATION MEDIUM INHOMOGENEITIES Final Report
A. J. Mallinckrodt 10 May 1967 32 p refs
(Contract NAS5-10009)
(NASA-CR-86630; CRL-523) CSCL 20N

The earth's atmosphere and the solar corona are considered for time-varying medium inhomogeneities. It is concluded that tropospheric fluctuations set a minimum bandwidth limitation of the order of 10^{-5} to 10^{-6} cps which is quite irrelevant at the present or foreseeable state-of-the-art. The solar corona is found to be a more nearly significant limitation. The effect is worst at low frequencies and depends markedly on the range of closest approach of the line-of-sight to the sun. Sufficient data is not available to directly infer phase modulation effects at approaches closer than 0.3 A.U. to the sun. However, indications of extrapolation laws are given. At 0.3 A.U. and for 1000 mc the total predicted phase modulation is 0.4 rad rms, in a bandwidth of 1/3 cps. Author

N67-32030# Eidgenossische Technische Hochschule, Zurich (Switzerland).
REFLECTION MEASUREMENTS IN TRANSMISSION TECHNOLOGY USING BROADBAND FREQUENCY MODULATION IN THE MICROWAVE REGION [REFLEXIONSMESSUNG IN DER LEITUNGTECHNIK MITTELS BREITBANDIGER FREQUENZMODULATION IM MIKROWELLENGEBIET]
Christoph Mahle (Ph.D. Thesis) 1966 88 p refs In GERMAN; ENGLISH summary
(DISS-3800) CFSTI: HC $3.00/MF $0.65

The theoretical bases are given, followed by a detailed investigation of the measurement of magnitude and distance of a number of reflections on a long transmission line and of the measurement of magnitude and phase angle of the voltage reflection coefficient of microwave components placed at the end of a long delay line. For the first case a system using FM radar is described which offers many advantages over a pulse radar of similar performance. For the second case a broadband impedance plotting system is presented capable to measure complex reflection coefficient with high precision and to present it in a Smith chart display. In each of the applications an experimental X-band waveguide version has been developed. The distance measuring system reached a sensitivity of −70 dB, an accuracy of ±1 dB for the magnitude and of ±3 cm for the distance of reflections. The Smith chart plotter reached a sensitivity of −60 dB, an accuracy of ±1 dB for the magnitude and of ±5° for the phase angle, corresponding to $\pm 0.12 \times r$ within the useful range of $0.001 < r < 1$. Author

N67-32097# Stanford Univ., Calif. Systems Theory Lab.
ANALYSIS OF COMMUNICATION SCHEMES USING AN INTERMITTENT FEEDBACK LINK
Anthony J. Kramer Mar. 1967 98 p refs
(Contract Nonr-225(83))
(SEL-67-014; TR-7050-11; AD-652825) CFSTI: HC $3.00/MF $0.65

Given any set of signals for use with a one-way communication channel, a feedback channel can be used to decrease the average power used by the transmitter while keeping the error probability the same, or equivalently, decreasing the error probability for the same average transmitter power. The case of orthogonal transmitter signals is analyzed in detail. The feedback channel is used only to tell the transmitter at certain specified times (prior to a final decision) which signal the receiver believes is being sent. The feedback information is used by the transmitter to modify its transmission according to a rule known also at the receiver. The feedback communication scheme is analyzed for both a noiseless and a noisy feedback link. In the case of noiseless feedback if only an average transmitter power constraint is imposed and orthogonal signals are used, it is possible to have the error probability go down in an N-fold exponential manner with increasing signal duration, where N-1 corresponds to the number of feedback iterations per message. This is in contrast to only a double exponential form for the error probability with some previously proposed feedback schemes. If a peak transmitter power constraint is also imposed, neither the N-fold exponential nor the double exponential behavior can be obtained. The peak power constraint limits the error probability expression to only a single-exponential form. Author (TAB)

N67-32099# Page Communications Engineers, Inc., Washington, D. C.
LONG DISTANCE VHF/UHF COMMUNICATIONS GROUND ANTENNA ARRAY Final Report
John H. Mc Mahon Feb. 1967 154 p refs
(Contract FA-64-WA-5177)
(SRDS-RD-67-11; AD-652614) CFSTI: HC $3.00/MF $0.65

A dual VHF/UHF antenna for ground-to-air extended range communication was developed. The antenna contains a 32 dipole VHF array (127–136 MHz) and a 32 dipole UHF array (277–328 MHz) in a 60 degrees screen corner reflector. The antenna including reflector is supported by a triangular guyed steel tower with a nominal 15-foot cross section. The supporting tower is 225 feet high. Each array is fed by a 50 ohm transmission line harness forming a binary corporate structure. The harness uses standard 7/8 in. and 1-5/8 in. flexible air dielectric 50 ohm cables and contractor-developed binary power dividers. The complete transmission line harness, binary transformers, and dipole feed points are pressurized with dry air from a dehydrator. This antenna has been installed at a site with an elevation of 6,600 feet on Mt. Haleakala, Maui, Hawaii. The main radiation lobes of the antenna are aligned on a bearing of 56 degrees true so as to center the beams on the mainland–Hawaii air routes. The radiation lobes of the antenna are electrically tilted −1.05° below the site horizontal to align the beam nearly on the site horizon. The tilt angle has been chosen to provide a horizon clearance of 0.2 ± 0.1°. The electrical tilt is provided by graded length cables in the binary harness at the feed points for each group of four dipoles. Author (TAB)

N67-32184*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING Quarterly Report, 6 Aug.–6 Nov. 1965

30 Nov. 1965 129 p ref
(Contract NAS5-9637)
(NASA-CR-74989; P65-149; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 17B

This report describes the work performed during this period on a parametric analysis of microwave and laser communication and tracking systems. Information and conclusions of previous studies were acquired and critiqued. The critiques list the significant contributions of each study and the location of the material within the body of the report. The critiquing has been completed for telecommunications and is in progress for the acquisition and tracking portion. Progress is reported on the three sections of a space design handbook. These sections include a methodology for solving space communication and tracking problems, parametric studies of the parameters involved in the methodology, and a state-of-the-art documentation of the parameters values. R.N.A.

N67-32165*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING
Quarterly Report, 6 Mar.–6 Jun. 1966
Jun. 1966 387 p refs
(Contract NAS5-9637)
(NASA-CR-77943; P66-135; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Five technical sections of the first issues of reference data for advanced space communications and tracking systems are updated. The sections include mission analysis, transmitting power sources, optical modulators, acquisition and tracking, and background radiation and atmospheric attenuation. Manned and unmanned space missions envisioned over the next several decades are summarized. The primary objectives of each mission are described and implied communication requirements are discussed. The transmitting power sources section is enlarged in the area of solid state power sources in the microwave region and in the area of CO_2 laser technology in the optical region. Acquisition and tracking efforts were directed towards documentation of the basic constraints within which an acquisition and tracking system must operate and an examination of the constraint effects on some general configurations. Some of the more important advances in optical modulation which are currently in progress are discussed and a section on elasto-optic modulation has been added. Current information concerning external noise sources relevant to optical and microwave space communication systems is presented. R.N.A.

N67-32166# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING
Quarterly Report, 6 Jun.–6 Sep. 1966
6 Sep. 1966 410 p refs
(Contract NAS5-9637)
(NASA-CR-82101; P66-213; QR-4) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Reference data for advanced communications and tracking systems are presented to provide a methodology for solving space communication and tracking problems, parametric studies of the parameters involved in the methodology, and a state-of-the-art documentation of the parameter values. In addition, an evaluation is made of the capability and amenability to modification of the available communication and tracking systems to the increased performance requirements of future microwave and optical communications systems. The presentation covers communication theory along with an analysis of the modulation, detection, and coding processes of communication systems; the performance and theory of radio frequency and optical detectors; acquisition and tracking with emphasis on a narrow beamwidth optical problem; radio frequency antennas for space and earth based applications; and key parameters and systems concepts of previous communications systems designs for comparison purposes. R.N.A.

N67-32167*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
PARAMETRIC ANALYSIS OF MICROWAVE AND LASER SYSTEMS FOR COMMUNICATION AND TRACKING
Quarterly Report, 6 Sep.–6 Dec. 1966
6 Dec. 1966 373 p refs
(Contract NAS5-9637)
(NASA-CR-87062; P67-09; QR-5) CFSTI: HC $3.00/MF $0.65 CSCL 17B

Reference data material are presented as an aide to a designer in determining an optimum communication and tracking system for a deep space vehicle. Efforts focused on updating the methodology; this resulted in a centerline design method which determines the optimum selection of several key communication system parameters on the basis of cost. An example is presented to show the solution to a deep space communication problem. Updated data are also presented on missions analysis, optics, prime power, and ground receiving sites. This information is treated in terms of theory and basic relationships; new variants of the technology and tabulated parameters and performance; burden relationships encompassing parameter values as a function of weight, cost, size, etc., and ancillary equipment; and nomenclature. A bibliography of references is included. M.G.J.

N67-32204# Joint Publications Research Service, Washington, D. C.
OPTIMAL BOUNDS OF CHECKING TOLERANCES
Yu. K. Belyayev and I. A. Ushakov *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 193–204 ref (See N67-32193 18-15)

Prior to the functioning of complex radioelectronic systems the correspondence of their output parameters to certain more rigorous checking tolerances is usually verified. The article deals with the selection of these tolerances, optimal from the standpoint of "customer's risk" and "supplier's risk," on considering that the checking equipment itself may involve measuring errors. Author

N67-32211# Joint Publications Research Service, Washington, D. C.
PHYSICS OF FAILURES AND THE DETERMINATION OF FAILURE RATE
B. S. Sotskov *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 294–311 (See N67-32193 18-15)

The article deals with the physics of failures of radio-equipment components. The relationship between reliability and the properties of materials, reliability and physico-chemical processes, and reliability and external factors is investigated. Author

N67-32219*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
COMMUNICATIONS AND NETWORKS
D. W. Tufts, A. A. Pandiscio, P. J. Trafton, H. Gish, and J. Proakis *In its* Cruft Lab. Mar. 1967 6 p refs (See N67-32215 19-34)

Electronics and communications work efforts on a digital/analog multiplier and a high speed photoformer, are reported. Work in communications theory included: (1) Data transmission by pulse amplitude modulation through a noisy channel that was randomly selected, (2) modulo-m linear sequential circuits, (3) adaptive receivers for digital signaling over random or unknown channels, (4) quantization and reconstruction of random sequences, and (5) band-pass limiter envelope distributions and statistics. L.S.

N67-32221*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
ELECTROMAGNETIC PHENOMENA

S. W. P. King, T. T. Wu, B. Ramo Rao, C. L. Chen, K. Iizuka et al *In its* Cruft Lab. Mar. 1967 7 p refs (See N67-32215 18-34)

(Grant NsG-685; Contract AF 19(628)-2406; Grant NSF GK-273)

Theoretical and experimental work efforts concerning electrically thick, thick cylindrical, infinitely long electrically thick, resistive, traveling wave, thin wire, electrically short, and long dipole antennas are discussed. Also considered are coupled antennas and arrays involving long coupled antennas, parallel circular arrays with two parallel electrically thick antennas, unequal and unequally spaced dipoles, planar and three-dimensional arrays, and circular loop arrays. Several studies concerning antennas and waves in dielectric conducting and plasma media are also discussed. L.S.

N67-32222# Joint Publications Research Service, Washington, D. C.

CYBERNETICS IN THE SERVICE OF COMMUNISM, VOLUME 3: THEORY OF INFORMATION, COMPUTER TECHNOLOGY, SEMIOTICS

A. I. Berg, ed. 29 Jun. 1967 269 p refs Transl. into ENGLISH of the book "Kibernetiku—Na Sluzhbu Kommunizmu, Teoriya Informatsii, Vychislitel-naya Tekhnika, Semiotika" Moscow, Izd. Energiya p 1–312

(JPRS-41633; TT-67-32266) CFSTI: HC $3.00/MF $0.65

Articles on transmission reliability and simplicity of codes, computer machine logic, and basic concepts and problems of semiotics, semantics and mathematical linguistics are presented. For individual titles see N67-32221–N67-32246.

N67-32223# Joint Publications Research Service, Washington, D. C.

THE THEORY OF OPTIMAL CODING OF INFORMATION

R. L. Dobrushin *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 9–50 refs (See N67-32222 18-07)

The present state of certain problems in the theory of optimal or near optimal coding and decoding of information is reviewed. Emphasis is placed on effective methods of coding and decoding information based on the combined use of probability and algebraic ideas of a combinatorial nature. The most promising area of coding theory is shown to be the synthesis of probability theory and algebraic methods. R.N.A.

N67-32224# Joint Publications Research Service, Washington, D. C.

CONDITIONS OF INVARIANCE IN A DECODING PROCEDURE

L. F. Borodin *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 51–76 refs (See N67-32222 18-07)

The problem of seeking optimal (minimum mean risk) procedures for coding and decoding a finite number of independent messages is analyzed. The conditions under which it is impossible to reduce the mean risk are defined by considering the uneven probability of messages being transmitted and the unequal value of decoding errors. The upper and lower estimates of the minimum attainable value of mean risk are given. R.N.A.

N67-32225# Joint Publications Research Service, Washington, D. C.

ONE CLASS OF CODES WITH CORRECTION OF INDEPENDENT ERRORS AND INDEPENDENT GROUPS OF ERRORS CAPABLE OF SIMPLE REALIZATION

Ye. T. Mironchikov and V. D. Kolesnik *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 77–86 refs Presented at the All-Union Conf. on Coding Theory and Its Appl., Odessa, May 1963 (See N67-32222 18-07)

A device for decoding cyclical group binary codes using the majority test decision principle is described. In comparison with the known methods of correcting multiple errors, this device provides a considerable gain in the number of elements used. The number of decoding circuit elements is not increased during the correction of independent groups of errors since the use of substitution $x \to x^b$ only redistributes the initial system of tests along the length of code nb. If for the correction of multiple errors the simplest of the decoding circuits is still more complex than the decoding circuit using the majority, then the advantage is particularly clear for the correction of independent groups of errors. Random and systematic errors in elements arising in the decoding circuit itself are also corrected. With a slight change in the circuit connecting the majority elements with the register, a similar decoding circuit is produced which is suitable for abbreviated pseudocyclical codes. R.N.A.

N67-32226# Joint Publications Research Service, Washington, D. C.

THE AVERAGE LENGTH OF A CODE WITH MINIMAL REDUNDANCY

S. S. Kinslitsyn *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 87–96 refs (See N67-32222 18-07)

The problem of constructing uneven codes with minimal redundancy is investigated. The problem involves determining the average length of a Huffman code during encoding of n symbols using a ciphers. In addition to their application in information theory, the formulas derived are useful for a number of problems in discrete search. Solutions are given for several cases involving nonbinary classes. R.N.A.

N67-32228# Joint Publications Research Service, Washington, D. C.

THE RELATION BETWEEN THE THEORY OF CORRECTING CODES AND PROBLEMS OF SELF-TEACHING AND RELIABILITY

A. N. Radchenko *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 104–139 refs (See N67-32222 18-07)

Problems concerned with increasing the effectiveness and reliability of correcting devices are investigated. The connection between self-teaching and reliability is analyzed in the light of the theory of correcting codes and its applications. A model developed for this purpose is analyzed to illustrate the connection between self-teaching and reliability. Author

N67-32229# Joint Publications Research Service, Washington, D. C.

THE INFORMATION LIMIT OF REDUNDANCY NECESSARY FOR CORRECTION OF ERRORS

S. I. Samoylenko *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 140–151 refs (See N67-32222 18-07)

An analysis is made of the lower limit of redundancy necessary to correct a certain fixed set of errors during information transmission through a discrete channel with noise by code combinations of a certain length. The minimal quantity of excess symbols needed to correct a given set of errors is defined in considering the probability of occurrence of these errors. The method used to solve this problem is based on calculating the quantity of information needed to describe a set of unequally probable events including the case of a corrected error appearing and the case of a noncorrectable error appearing or not appearing. The lower limit of the number of redundant symbols produced is called the information limit of redundancy. When the correcting codes are used with fixed redundancy, the limit cannot be achieved in all code combinations. In order to approach the information limit, it is necessary to use methods of information transmission with redundancy controlled by the results of reception. R.N.A.

N67-32230# Joint Publications Research Service, Washington, D. C.

LIMITING VALUES OF REDUNDANCY IN CORRECTING CODES

S. I. Samoylenko *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 152–162 refs (See N67-32222 18-07)

A brief review is made of the methods of determining the limiting values of redundancy needed to construct codes for correcting mutually independent and group errors. All the methods analyzed are based on the assumption that any code combination should contain redundancy sufficient to correct any permissible error. In the actual transmission of information, most code combinations contain no errors so that the probability of the various forms of errors appearing is not identical. Therefore the number of redundant symbols needed to correct these errors may be lower than in the case when the possibility of correcting any permissible error in each code combination is provided. R.N.A.

N67-32231# Joint Publications Research Service, Washington, D. C.

PROBLEMS OF LINEAR ENCODING OF A MOVING IMAGE

B. S. Tsybakov *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 163–180 refs (See N67-32222 18-07)

An analysis is made of the possibilities of increasing the interference stability of transmitted moving images in low frame rate television systems by the use of three-dimensional linear coding and decoding. A theory of multi-dimensional linear methods of coding and decoding is developed along with a corresponding method of calculating the optimal coding and decoding filter characteristics. R.N.A.

N67-32233# Joint Publications Research Service, Washington, D. C.

THE ENTROPY OF SOURCES OF VISUAL MESSAGES

A. B. Levit *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 189–208 refs (See N67-32222 18-07)

Quantitative estimates are made of the formation rate of messages by a television source. Several works in this area are analyzed and the substitution of a multi-dimensional message by a unidimensional video signal is shown to be impermissible. A new method is suggested for the quantitative estimate of the entropy of television message sources. This method is based on a multi-dimensional model of the message. Problems involving the statistics of the television images are formulated. Due to the absence of the necessary statistical material, no calculations were made of the entropy of actual sources. However, upper estimates for this quantity are given. R.N.A.

N67-32243# Joint Publications Research Service, Washington, D. C.

THE PROBLEM OF DEFINING THE BASIC CONCEPTS OF SEMIOTICS

Yu. A. Shreyder *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 315–332 refs (See N67-32222 18-07)

An attempt is made to define the subject of semiotics and its basic concepts, including syntactics, semantics, and pragmatics. In addition, such concepts as the sign system, language, translation from language to language, and equamorphism of sign systems are studied in order to give a clear understanding of the application of precise methods to the study of sign systems. R.N.A.

N67-32244# Joint Publications Research Service, Washington, D. C.

ATTEMPT AT SEMANTIC INTERPRETATION OF THE STATISTICAL CONCEPTS OF INFORMATION AND ENTROPY

Ye. K. Voyshvillo *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 333–358 refs (See N67-32222 18-07)

A semantic interpretation is proposed for the statistical concepts of Shannon's theory of information within the framework of the calculus of questions. Concepts related to the semantic information theory of Karnap and Bar-khillel are included in the interpretation. R.N.A.

N67-32245# Joint Publications Research Service, Washington, D. C.

CYBERNETICS AND CERTAIN PROBLEMS OF MODERN LINGUISTICS

I. A. Mel'chuk and R. M. Frumkina *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 359–369 refs (See N67-32222 18-07)

The various contributions of cybernetics to the study of linguistics are discussed. Of particular interest are the mathematical models which are being used to study the structure of natural language. The study of linguistics has, in turn, contributed to the further development and improvement of computers by attempting to transfer some of man's mental activity to them, which is closely connected with computer learning of natural languages. The development of cybernetic theory has led to the necessity of direct communication between man and machine through natural language. Since language is a complex system, it is the very type of problem suitable to study by cybernetics. Linguistics may give cybernetics interesting factual material and may in turn be a useful field for the application and improvement of cybernetic methods. Several language models are described along with self-teaching and self-regulating requirements for a model. A few theoretical problems concerned with developing automatic operating language models are discussed. R.N.A.

N67-32246# Joint Publications Research Service, Washington, D. C.

PRINCIPLES OF DISTRIBUTIVE ANALYSIS OF VERB AFFIXATION (BASED ON BELORUSSIAN LANGUAGE MATERIAL)

V. V. Martynov, P. P. Shuba, and M. I. Yarmosh *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 370–378 refs (See N67-32222 18-07)

The structure of natural language can be described if a set of elementary units and rules for their apposition and distribution are fixed. Since every natural language is analyzed from the viewpoint of its three basic levels (phonematic, morphematic, and syntactic), each level has its own elements (phonemes, morphemes, and syntagms). The distribution of a fixed set of verb affixes (affix morphemes) can be studied independently from the verb roots. However, since the word forming models are dependent on the semantics of the forming roots, a set of forming roots is necessary. This latter set is not fixed because the number of forming roots is great and increases constantly. However, a set of semantic classes of forming roots can be noted. The division of the set of forming roots into classes is equivalent to separating the most common semantic characteristics of the roots. An attempt is made to quantitatively evaluate the combinability of any semantic class of forming roots with any affix morphemes, any affix morpheme with any semantic class of forming roots, and any affix morpheme with an affix morpheme. It is assumed that near universal regularities can be established in this type of combinability. Author

N67-32274*# California Univ., Berkeley. Space Sciences Lab.
A GEOMETRIC TREATMENT OF THE PROBLEM OF SOURCE ENCODING A GAUSSIAN RANDOM VARIABLE
David J. Sakrison 31 Jan. 1967 21 p refs *Its* Tech Memo Ser. No. 8, Issue No. 3
(Grant NGR-05-003-143)
(NASA-CR-83398) CSCL 09D

This paper gives a geometric treatment of the source encoding of a gaussian random variable for minimum mean-square-error. The first section gives a geometric derivation of Shannon's classic result which explicitly shows the steps in source encoding and the properties that a near optimum code must possess. The second section makes use of the geometric insight gained in the first section to bound the performance that can be obtained with a finite block length of L random variables. It is shown that a code can be found whose performance approaches that of the rate distortion function as 1/L in mean-square-error and in L/L in rate. Author

N67-32322*# Hughes Aircraft Co., Culver City, Calif. Aerospace Group.
REFERENCE DATA FOR ADVANCED SPACE COMMUNICATIONS AND TRACKING SYSTEMS
6 Feb. 1966 526 p refs
(Contract NAS5-9637)
(NASA-CR-86910; P66-16) CSCL 17G

Overall systems trade-off studies were conducted in sufficient detail to identify missions which will make the best use of laser/optical, microwave, or a combination of microwave and laser/optical communication and tracking systems. A plan is presented for optimumly integrating such systems into present and future world-wide systems. Systems design criteria and specifications are provided, along with the methodology which provides a basis for determining the optimum system configuration. C.T.C.

N67-32327# Micro-Radionics, Inc., Van Nuys, Calif.
LOW COST CAPTURE EFFECT GLIDE SLOPE AMPLITUDE AND PHASE CONTROL UNIT Final Report
Jack Catran and Michael A. Midwin 10 Aug. 1966 30 p
(Contract FA65WA-1213)
(RD-66-58; AD-652939) CFSTI: HC $3.00/MF $0.65

The primary objective of the program was to design, develop, and manufacture, within the requirements of the specification, an equipment which would: operate in the 328 mc to 336 mc glide slope band; accept, combine, and mix signals from three different sources into the appropriate phase and amplitude relationship; and deliver the signals to three FAA supplied glide slope transmitting antennas. Full use was made of the Micro-Radionics AIR-STRIP technique. The tasks, activities, conclusions, and recommendations are sequentially presented for the entire life of the program, from award of contract through qualification and acceptance. A value and performance analysis of low-cost copper-clad base laminates was conducted, which resulted in an extensive investigation of all known materials. A special RF connector was used, to save the cost of modifying the UC-58A/U Type N connectors which required the installation of connecting links and pins. Simplicity and low cost were emphasized in the design of the RF probe coupler, and the crystal detector was located on the external surface of the package to provide maximum accessibility during crystal replacement. The hybrids used for the power divider were located so that the phase shifters could be mounted logically and the length of all transmission lines were kept to a minimum to reduce phase error. The development of the principal subsystems are discussed in detail. Because the equipment has the inherent performance capabilities required to successfully meet the specified criteria, it is recommended that no changes be made. Author (TAB)

N67-32337# Bell Bros. Research Corp., Boulder, Colo.
A BIAXIAL CONTROL AND DRIVE SYSTEM FOR SPACECRAFT ANTENNA ORIENTATION
G. R. Strevey 4 Feb. 1967 10 p
(TN-67-05)

A biaxial control and drive system to orient a directional antenna from an orbiting spacecraft is described. The system, which is lightweight and operates on low power, provides both waveguide and coaxial cable gimbal crossing for rf signals. In addition to a biaxial drive assembly, the system contains an electronic control unit. Command, autotrack, and stow modes of operation are possible, with pointing accuracy for the command mode ±0.3 deg and for autotrack ±0.2 deg. M.W.R.

N67-32385# Northeastern Univ., Boston, Mass. Dept. of Electrical Engineering.
ON THE THEORY OF WIND MEASUREMENT WITH INCOHERENT RADAR
Walter H. Lob 1 Jul. 1966 32 p refs
(Contract AF 19(628)-4956)
(AFCRL-66-501; SR-2; AD-652857) CFSTI: HC $3.00/MF $0.65

The ideas of Atlas and Wexler on wind measurement using a dual-beam incoherent radar have been extended. An alternate theory for this measurement technique is presented. It is shown that the normalized Doppler spectrum can be obtained by convolving the normalized contamination spectrum (shifted by the radial component of the wind) with the normalized antenna pattern (stretched by the tangential component of the wind). This approach allows the following generalizations from the theory of Atlas and Wexler: The two beams need not be identical in shape and peak gain; The individual antenna patterns need not be Gaussian; The angle between the beams may be large; The volumes observed by the two beams need not have equal reflectivity and equal contamination variance. Author (TAB)

N67-32403* Brown (D.) Associates, Inc., Eau Gallie, Fla.
GEODETIC DATA ANALYSIS FOR GEOS A, AN EXPERIMENTAL DESIGN Final Report
Duane C. Brown, J. Graham Hartwell, John W. Stephenson, and James B. Willmann [1967] 152 p refs
(Contract NAS5-9860)
(NASA-CR-86577) CSCL 09F

The general problem of the design of experiments for the acquisition, processing and analysis of data from the GEOS A Satellite is discussed in detail. The application of rigorous statistical data processing methods to the solution of various geodetic problems is described. Specific discussion of the problems associated with the recovery of station survey information and error model coefficient information is included. A power series method for the integration of orbits and the generation of matrizants is provided. The logical organization of the data handling and data flow is presented. Author

N67-32460# Radiation, Inc., Melbourne, Fla. Radiation Systems Div.
SATELLITE COMMUNICATIONS TERMINAL, AN/TSC-54, VOLUME III Quarterly Report, 15 Sep. 1966–15 Jan. 1966
15 Jan. 1966 375 p
(Contract DA-28-04-AMC-01685(S))
(Doc.-1165-00-4, Vol. 3, App. K; QR-1; AD-372685) CFSTI: HC $3.00/MF $0.65 (Declassified)

The updated design plan for the Satellite Communications Terminal AN/TSC-54 is presented. R.N.A.

N67-32474# Serendipity Associates, Los Altos, Calif.
AN OPERATIONAL CONCEPT OF AN EMERGENCY MEDICAL COMMAND AND COMMUNICATIONS SYSTEM Final Report

Richard E. Shoemaker and Barry Korn Feb. 1967 107 p refs
(Contract N00228-66-C-1616)
(TR-44-67-1; AD-653105) CFSTI: HC $3.00/MF $0.65

An operational concept for an Emergency Medical Command and Communications System (EMCCS) is derived from an analysis of natural disaster reports and the anticipated conditions attending a nuclear attack. A conceptual EMCCS model is described in terms of system elements, types of information circulated, communications links and traffic load determinants. A general approach to implementation of an EMCCS is described with a brief discussion of constraints imposed by current commitments and projected changes. The importance of validating the conceptual EMCCS is discussed and future research is suggested. Author (TAB)

N67-32491# Bell Telephone Labs., Inc., New York.
DETECTION OF A SIGNAL WITH AN UNKNOWN PARAMETER
Ira Jacobs 17 Aug. 1966 12 p
(Contract N00014-66-C-0005)
(TR-12; AD-652808) CFSTI: HC $3.00/MF $0.65

Preliminary consideration is given to the general problem of the detection of a signal that depends on an unknown parameter. Two detection procedures are contrasted: (1) a likelihood ratio detector plus maximum likelihood estimator, and (2) a combined maximum likelihood detector and estimator. The latter has the apparent advantage of not requiring a priori knowledge of the distribution of the parameter, but this oft-stated advantage is shown to be misleading. Special cases considered indicate that the former procedure, which has a firmer theoretical basis, becomes relatively insensitive to a priori knowledge when sufficient data are present. Author (TAB)

N67-32511# Navy Electronics Lab., San Diego, Calif.
TUNABLE 4–8 MC/S, HIGH-POWER, MODERATE-Q TRANSMITTING ANTENNA Research and Development Report, Feb. 1965–Oct. 1966
E. A. Thowless 7 Apr. 1967 39 p refs
(NEL-1450; AD-653287) CFSTI: HC $3.00/MF $0.65

A high-frequency transmitting antenna was developed for shore-station use. The antenna allows a 40-kW PEP transmitter to operate anywhere within the 4-8 Mc/s frequency range. The low VSWR (less than 1.5:1) allows use of 1-5/8-inch, 50-ohm, semiflexible, air-dielectric coaxial line. The design permits improved space utilization at shore stations. An engineering prototype has been installed at the Naval Radio Station (T), Mare Island, Vallejo, California, for operational evaluation. Author (TAB)

N67-32517# Army Engineer Geodesy, Intelligence and Mapping Research and Development Agency, Fort Belvoir, Va.
AN AUTOMATIC-ELECTRO OPTICAL SATELLITE TRIANGULATION SYSTEM
Arne Bjerhammar Apr. 1967 45 p refs
(GIMRADA-RN-23; AD-652882) CFSTI: HC $3.00/MF $0.65

The passage of light-emitting targets over a special reticule of a telescope are recorded by photoelectric means on (magnetic) tape and then processed in an electric computer. The system is useful for satellite triangulation and studies of trajectories. Author (TAB)

N67-32523# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
RADAR PRECIPITATION ECHOES EXPERIMENTS ON TEMPORAL, SPATIAL, AND FREQUENCY CORRELATION
Fred E. Nathanson and J. Patrick Reilly Apr. 1967 55 p refs
(Contract NOw-62-0604-c)
(TG-899; AD-652818) CFSTI: HC $3.00/MF $0.65

Radar clutter, the unwanted echoes from the sea, terrain, precipitation, or chaff, can seriously limit radar performance. While numerous clutter rejection techniques have been proposed, the radar engineer has often been unable to evaluate them accurately because descriptions of the properties of the clutter signals are often inaccurate or incomplete. What the engineer needs, then, is a reasonably complete model of the clutter environment. In response to this need, the MRT Group of the Applied Physics Laboratory performed a series of experiments during 1966 to describe the characteristics of clutter in a manner that would suit the needs of the radar engineer. This document summarizes the results of experiments on precipitation clutter. The goal of these experiments was to provide for the radar engineer a description of the spectrum, the spatial uniformity, and the frequency correlation properties of precipitation echoes. These experiments resulted in a more complete description of the clutter spectra than has heretofore been available. The wind shear phenomenon was found to have a dominant effect on the spectra at distant ranges. Other results show that the mean backscatter cross section is rarely uniform in space and that the frequency correlation characteristics confirm the theory predicting that echoes from pulses separated in frequency by at least the reciprocal of the pulse width are uncorrelated. TAB

N67-32534*# Michigan Univ., Ann Arbor. Office of Research Administration.
[INVESTIGATIONS IN SPACE COMMUNICATIONS THEORY, INCLUDING TOPICS RELATED TO RANDOM PROCESSES, FILTERING, TELEMETRY] Semiannual Status Report, 1 Oct. 1966–31 Mar. 1967
Frederick J. Beutler, Lawrence L. Rauch, and William L. Root 14 Jul. 1967 3 p refs
(Grant NsG-2-59)
(NASA-CR-87004; Rept.-02905-18-P) CFSTI: HC $3.00/MF $0.65 CSCL 09F

Brief abstracts of research papers are given. Topics covered are: (1) *Random Sampling of Random Processes: Impulse processes*—expressions and theoretical models for spectral density of impulse processes, and alias-free sampling of random processes by sampling at random instants; (2) *The Use of Statistical Dependence Between Data Samples in Binary PCM Demodulation*—optimum and suboptimum demodulation, and improved analog demodulation; (3) *Identification of Unknown Systems*—identification from input–output data of systems which can be represented by integral operators; and (4) *Capacity of Classes of Gaussian Channels*—generalization of discrete-time, memoryless Gaussian channel. G.G.

N67-32561# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
THE DESIGN OF MODULAR TELEMETRY TRANSMITTERS FOR SATELLITE APPLICATIONS
T. Thompson and E. H. Spedden Mar. 1967 93 p
(Contract NOw-62-0604-c)
(TG-887; AD-652808) CFSTI: HC $3.00/MF $0.65

All solid-state telemetry transmitters of APL design were first used in APL satellites in place of commercially designed units in 1961. A second-generation transmitter composed of individual functional modules was designed to replace the original units beginning with the GEOS satellite launched in 1965. A total of fifteen satellites have used APL designed transmitters, of which four are of the newer modular configuration. As of January 1967, ten of these satellites were operational. Modular TM transmitters can be constructed with more confidence because the assembler works on a less complex unit. Testing is simpler. Quality control inspections are more rigorously defined. Six standard modules, comprising a crystal oscillator, phase modulator, frequency multiplier, and power amplifiers, are discussed in detail. In addition, present and future special-purpose modules are presented. Particular emphasis is placed on the analysis of linear phase modulators and the engineering philosophy that led to the modular concept, including packaging, testing procedures, quality control, and thermal design. TAB

N67-32568# Harry Diamond Labs., Washington, D. C.
A FUZE-TELEMETRY ANTENNA-TRANSMITTER
Howard Bassen Feb. 1967 21 p ref
(HDL-TR-1343; AD-653126) CFSTI: HC $3.00/MF $0.65

An integrated antenna-transmitter was developed to telemeter data from inflight artillery fuzes with minimum modification of either fuze or shell. The strip transmission line antenna provides a wide, uniform radiation pattern while providing stability to a rugged and easily fabricated VHF transmitter. Incorporation of the antenna as the tuned circuit of the oscillator stage of this FM transmitter proved to be the optimum utilization of this compact ring antenna. Author (TAB)

N67-32579*# Houston Univ., Tex. Dept. of Electrical Engineering.
GENERAL MULTIPLEXING THEORY Semiannual Progress Report
R. D. Shelton and Stephen Riter [1967] 80 p refs
(Grant NGR-44-005-039)
(NASA-CR-87002) CSCL 17B

A general model is derived to describe all possible multiplexing systems except those for which the messages determine the value of the output in a non-real-time manner. A review of multiplexing systems is presented, emphasizing frequency division multiplexing and time division multiplexing. It was found difficult to determine optimum multiplexing systems for a given combination of restraints, and a different approach is described which yields a realistic standard of comparison for practical communications channels. The expected state-of-the-art of spacecraft-to-ground communications for 1970–1975 is also examined, to determine the communications system performance for manned interplanetary exploration. It was concluded that the all-digital phase shift keying system gives a considerable theoretical advantage over the optimum unified S-band system. N.E.N.

N67-32625*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
CONCEPTUAL MECHANIZATION STUDIES FOR A HORIZON DEFINITION SPACECRAFT COMMUNICATIONS AND DATA HANDLING SUBSYSTEM
Raymond J. Kirk, Joseph Kahnke, and David J. Hartman May 1967 209 p refs
(Contract NAS1-6010)
(NASA-CR-66381) CFSTI: HC $3.00/MF $0.65 CSCL 17B

The data handling and communication subsystems design requirements and a feasible subsystem concept are developed. The tradeoff studies are documented to show the logic used to arrive at the recommended concept. The data handling subsystem in its present concept is a completely solid-state system, well within the state of the art. All scientific data on the spacecraft is digitized, stored in a 515 455 bit solid-state memory, and transmitted to telemetry stations approximately once per orbit. The concept provides the capability of meeting the recommended data requirements of 378 508 horizon profiles in one year and has flexibility to take additional data in "interesting" locations. The communications subsystem requires telemetry transmission in the 136 MHz vhf band to achieve maximum station contact and S-band transponder operation for vehicle tracking to achieve the required tracking accuracy. Including the capability of connecting these units into redundant and/or backup modes of operation provides a highly reliable communications subsystem. The subsystem is feasible, within the state of the art, and requires no alterations to the NASA Spacecraft Tracking and Data Acquisition Network (STADAN). Author

N67-32869# Communication Systems, Inc., Paramus, N. J.
A STUDY LEADING TO THE CONSTRUCTION OF A TROPOSCATTER SIMULATOR Quarterly Report, Jan.–Mar. 1967
M. Klein May 1967 19 p
(Contract DA-28-043-AMC-02545(E))
(CSI-67-TR-2374; ECOM-02545-3; AD-652279) CFSTI: HC $3.00/MF $0.65

The work during this period was mainly circuit design and hardware procurement. Chassis construction and printed circuit board fabrication was begun. The varilossers and buffers were changed to use a differential amplifier configuration to decrease loading effects. The cable equalizers use a cascode configuration to obtain higher gain. The programming effort for the simulator continued during this period. The extended arithmetic feature was installed in the PDP-8 and checked out. Several routines for testing the simulator hardware were written and debugged. Author (TAB)

N67-32884# Communication Systems, Inc., Paramus, N. J.
WIDEBAND DIGITAL MODULATION AND DETECTION TECHNIQUES FOR TROPOSCATTER Quarterly Report, 1 Jan.–31 Mar. 1967
E. Levine, R. T. Adams, and P. Grobert May 1967 44 p
(Contract DA-28-043-AMC-02542(E))
(ECOM-02542-3; QR-3; Rept.-3; CSI-67-TR-2380; AD-653159) CFSTI: HC $3.00/MF $0.65

The program objective is to identify and breadboard the modulation technique offering best performance for transmission of high digital data rates over tactical troposcatter paths of 50 to 150 miles at 5 ghz. The study is concerned with higher order modulation coding, in-band diversity and other techniques that may bring about an optimal match to the medium. The prime traffic rates under consideration are 0.576 and 1.15 megabits per second. During this quarter, a specific near-optimum modulation technique was chosen for implementation, and the necessary circuits for transmitter and receiver were planned and analyzed in detail. A tentative set of circuit block diagrams was completed. This circuit was then refined and it was found possible to simplify parts of the receiver circuitry by modifying the specific detection process used. With the first-choice modulation pattern fully analyzed, and the required circuits outlined in detail, it became possible to consider trade-offs of cost, complexity, probable reliability and size factors, and overall performance as a function of simplification and modification in the choice of pattern. A particularly attractive simplified choice of modulation pattern results in about two to one reduction in circuit cost and complexity, and appears to have theoretical advantages in links having a wide correlation bandwidth, allowing wider frequency spacing for in-band diversity. Author (TAB)

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-31809*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A GENERAL-PURPOSE ON-BOARD PROCESSOR FOR SCIENTIFIC SPACECRAFT
F. Styles, T. Taylor, M. Tharpe, and C. Trevethan Jul. 1967 29 p
(NASA-TM-X-55843; X-562-67-202) CFSTI: HC $3.00/MF $0.65 CSCL 09B

This paper describes a general-purpose stored program digital computer for use on scientific spacecraft. The computer, called the on-board processor (OBP), has been designed to meet the objectives of multimission applicability, increased experiment capability, and simplified software construction with reliability being emphasized at both the system and component levels. This report includes a description of the processor's grammatically structured machine language together with a delineation of the central

processing unit, input/output philosophy, and modular memory. Proposed circuitry and packaging techniques for both the engineering model and flight systems are presented. Author

N67-31743* Oak Ridge National Lab., Tenn.
PUT-5 AND TAKE-5: TWO MAGNETIC TAPE SYSTEMS ROUTINES FOR THE PDP-8
B. W. Rust and W. R. Burrus 22 Mar. 1967 18 p
(NASA Order R-104(1))
(NASA-CR-85762; ORNL-TM-1805) CSCL 09B

Two magnetic tape systems routines have been written to provide fast input of programs or data to a PDP-8 computer from a tape transport. PUT-5 is used to create systems tapes containing the user's programs and TAKE-5 is used to read the programs into the computer from such systems tapes. Author

N67-31881# Wissenschaftliche Gesellschaft fur Luft- und Raumfahrt, Cologne (West Germany).
REPORT OF THE SESSION OF THE WGLR SUBCOMMITTEE ON AERODYNAMICAL COMPUTER TECHNOLOGY [BERICHT UEBER DIE SITZUNG DES WGLR-UNTERAUSSCHUSSES AERODYNAMISCHE MESSTECHNIK]
May 1966 220 p refs In GERMAN Conf. held at Munich, 12 Mar. 1965
(DLR-MITT-66-04) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. COMPARISON OF ANALOG AND DIGITAL COMPUTING PROCESSES A. Becker (Deutsche Forschungsanstalt fur Luft- und Raumfahrt) p 7–32 refs (See N67-31882 18-08)

2. DATA PROCESSING ELEMENTS IN INTERPOLATION TECHNOLOGY FOR TEST DATA RETRIEVAL, DATA PROCESSING AND DATA INDEXING N. Chismon (Electron. Associates, G.m.b.H.) p 33–48 (See N67-31883 18-08)

3. PCM BIT DETECTORS WITH IMPROVED ERROR PROBABILITY F. Neumayer (Beckman Instr. G.m.b.H.) p 49–63 refs (See N67-31884 18-08)

4. THE MULTIPLEX TECHNIQUES FOR TRANSFERRING MORE DATA OVER A TRANSMISSION CHANNEL H. Bothe (Deutsche Forschungsanstalt fur Luft- und Raumfahrt) p 65–81 refs (See N67-31885 18-08)

5. AUTOMATIC RETRIEVAL OF THE CALIBRATION POINTS OF DATA TRANSFORMERS USING A PRESSURE IMPULSE TRANSMITTER E. Binder (Bolkow Entwicklungen K.G.) p 83–104 (See N67-31886 18-09)

6. STATISTICAL DATA PROCESSING IN THE SCOPE OF THE DO 31 TEST PROGRAM C. Miller and G. Schweizer (Dornier-Werke G.m.b.H.) p 105–137 refs (See N67-31887 18-08)

7. QUICK DATA RETRIEVAL SYSTEM WITH MAGNETOSTRICTIVE DELAY LINES AS INTERMEDIATE RESERVOIRS F. Neumayer (Beckman Instr. G.m.b.H.) p 147–162 refs (See N67-31889 18-08)

8. DIGITAL DATA RETRIEVAL FACILITY FOR A BLOW DOWN SUPERSONIC WIND TUNNEL A. Heyser and H. Zlobinski (Deutsche Versuchsanstalt fur Luft- und Raumfahrt) p 147–162 refs (See N67-31889 18-11)

9. OPERATION OF DIGITAL COMPUTER TECHNOLOGY IN TRANSMISSION RESEARCH F. V. Burger-Scheidlin (Deutsche Forschungsanstalt fur Luft- und Raumfahrt) p 163–175 (See N67-31890 18-08)

10. EXPERIENCES WITH AN ANALOG-DIGITAL DATA RETRIEVAL FACILITY B. Dittie (Deutsche Versuchsanstalt fur Luft- und Raumfahrt) p 177–185 ref (See N67-31891 18-08)

11. A DIGITAL COMPUTER FOR MEASURING FUEL SUPPLY AND FUEL CONSUMPTION L. Koch (Deutsche Versuchsanstalt fur Luft- und Raumfahrt) p 187–199 (See N67-31892 18-08)

12. DATA PREPARATION AND DATA PROCESSING OF ANALOG DATA IN FREE FLIGHT RESEARCH E. Ahlborn (Bolkow Entwicklungen K. G.) p 201–216 (See N67-31893 18-08)

N67-31882# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugfuehrung.
COMPARISON OF ANALOG AND DIGITAL COMPUTING PROCESSES [VERGLEICH ANALOGER UND DIGITALER MESSVERFAHREN]
A. Becker *In* WGLR Rept. of the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 7–32 refs (See N67-31881 18-08)

Comparison between signals of high and low step numbers showed that binary digital computations provide a higher stability against external and internal disturbances, and at the same time possess a wider bandwidth. Their simplicity, data reduction possibility, and memory ability can be utilized for optimal control processes. Transl. by G.G.

N67-31883# Electronic Associates G.m.b.H., Aachen (West Germany).
DATA PROCESSING ELEMENTS IN INTERPOLATION TECHNOLOGY FOR TEST DATA RETRIEVAL, DATA PROCESSING AND DATA INDEXING [DATENVERARBEITUNGSELEMENTE IN EINSCHUBTECHNIK FUER MESSWERTERFASSUNG, MESSWERTVERARBEITUNG UND MESSWERTREGISTRIERUNG]
N. Chismon *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 33–48 (See N67-31881 18-08)

The concept of plug-in computer programming is presented together with its interface unit and available plug-in converters from analog input signals to tape punch. Described are 2 analog-digital converters; one an 8-bit analog-digital converter and the other a 12-bit analog-digital converter, with their specific memories and plug-ins. Transl. by G.G.

N67-31884# Beckman Instruments G.m.b.H., Munich (West Germany).
PCM BIT DETECTORS WITH IMPROVED ERROR PROBABILITY [PCM BIT DETEKTOREN MIT VERBESSERTER FEHLER-WAHRSCHEINLICHKEIT]
F. Neumayer *In* WGLR Rep. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 49–63 refs (See N67-31881 18-08)

Incorporation of difference-integration detectors into split-phase codes, together with spot samplers and digital integrators, is evaluated. The detection of bit pairs constitutes an improvement of 3 db in comparison with single bit detection and insures better drift suppression. Even low frequency fluctuations, especially from magnetic tapes, are decreased to 1/4 of the bit rate. At a bit error probability of 10^{-8} an improvement of 3 db in the signal/noise voltage ratio constitutes a decrease in the failure probability factor of 1000. Transl. by G.G.

N67-31885# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Flugfuehrung.
THE MULTIPLEX TECHNIQUES OF TRANSFERRING MORE DATA OVER A TRANSMISSION CHANNEL [DIE MULTIPLEXTECHNIK ZUR UEBERTRAGUNG MEHRERER MESSWERTE UEBER EINEN UEBERTRAGUNGSKANAL]
H. Bothe *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 65–81 refs (See N67-31881 18-08)

Described are the basic principles of frequency and time multiplexing techniques and the conditions for their incorporation into common channels. Comparison of their specific advantages and disadvantages shows that both systems compliment each other and can be used concurrently side by side in space vehicle telemetry. Transl. by G.G.

N67-31887# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
STATISTICAL DATA PROCESSING IN THE SCOPE OF THE DO 31 TEST PROGRAM [STATISTISCHE MESSWERTVERARBEITUNG IM RAHMEN DES DO 31-VERSUCHSPROGRAMMES]
C. Miller and G. Schweizer *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 105–137 refs (See N67-31881 18-08)

Theoretical and practical aspects on digital calculation of the correlation functions in random experimental data are described. About 700 to 900 measurements from 100 glider flight tests each of 3 minute duration, were correlated by applying automatic data acquisition and reduction techniques with magnetic tape imprint and graphic impulse presentation. Transl. by G.G.

N67-31888# Beckman Instruments G.m.b.H., Munich (West Germany).
QUICK DATA RETRIEVAL SYSTEM WITH MAGNETOSTRICTIVE DELAY LINES AS INTERMEDIATE RESERVOIRS [SCHNELLES DATENERFASSUNGSSYSTEM MIT MAGNETOSTRIKTIVEN VERZOEGERUNGSLEITUNGEN ALS ZWISCHENSPEICHER]
F. Neumayer *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 139–145 (See N67-31881 18-08)

Analog-to-digital converters, able to change 250,000 impulses in one 10-bit binary word per second, are interconnected in a system with 20 measurement pick-offs. This increases the amount of analog-to-digital conversions to 1,000,000 per second. The system utilizes one analog reservoir per channel, followed by the rapid analog-to-digital converter and a magnetostrictive delay line as intermediate memory. A block diagram for the system is included. Transl. by G.G.

N67-31890# Deutsche Forschungsanstalt für Luft- und Raumfahrt, Brunswick (West Germany). Institut fuer Strahlantriebe.
OPERATION OF DIGITAL COMPUTER TECHNOLOGY IN TRANSMISSION RESEARCH [EINSATZ DER DIGITALMESSTECHNIK BEI DER TRIEBWERKSUNTERSUCHUNG]
F. v. Burger–Scheidlin *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 163–175 (See N67-31881 18-08)

Application of the digital indicator principle to quality control and engine inspection by the engineer is considered. Digital measurements of counted impulses are obtained by the following two methods: (1) direct impulse counting during a time limit; and (2) counting of impulses passing through an open gate during a certain period. Which of the two methods is applicable to a task depends on the accuracy requirements and the allowable margin. Transl. by G.G.

N67-31891# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany).
EXPERIENCES WITH AN ANALOG–DIGITAL DATA RETRIEVAL FACILITY [ERFAHRUNGEN MIT EINER ANALOG–DIGITALEN MESSWERTERFASSUNGSANLAGE]
B. Dittie *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 177–185 refs (See N67-31881 18-08)

Described is an analog-to-digital measurement data aquisition system for the test evaluation of turbine engines. The system combines digital data aquisition with partial data evaluation in an analog computer to regulate test runs into desired parameters. Transl. by G.G.

N67-31892# Deutsche Versuchsanstalt für Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Institut fuer Flugmechanik.
A DIGITAL COMPUTER FOR MEASURING FUEL SUPPLY AND FUEL CONSUMPTION [EIN DIGITALES MESSGERAET ZUR MESSUNG VON KRAFTSTOFFVORRAT UND -VERBRAUCH]
L. Koch *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn May 1966 p 187–198 (See N67-31881 18-08)

Accurate measurements on fuel consumption and fuel reservoir during test flights are obtained by a digital flow meter system that incorporates a binary frequency divider. The meter consists of a cylinder wheel that is agitated by the fuel flow; its rate of resolution depends linear on the flow velocity and is readily measured by frequency impulses. An analog-to-digital converter transforms the quantitative signal then into a number display. Block diagrams and pictures of the apparatus are included. Transl. by G.G.

N67-31893# Bolkow Entwicklungen K. G., Munich (West Germany).
DATA PREPARATION AND DATA PROCESSING OF ANALOG DATA IN FREE FLIGHT RESEARCH [DATENAUFBEREITUNG UND -VERARBEITUNG VON ANALOGEN MESSWERTEN BEI FREIFLUGVERSUCHEN]
E. Ahlborn *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 201–216 (See N67-31881 18-08)

Free flight measurement data are telemetered by pulse amplification method to the ground station where they are collected on magnetic tape and film. The collected multiplex signals are then evaluated by decoding, and conversion to digital printout. Transl. by G.G.

N67-32029*# Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center.
COMPATIBLE AUTOMATED LIBRARY CIRCULATION CONTROL SYSTEMS
Charles R. Umstead and Fred E. Croxton 15 Apr. 1967 176 p ref
(NASA-TM-X-60081; RSIC-663) CSCL 05B

This report describes five more or less standard and highly compatible circulation systems which incorporate a common form of input and which require a minimum of conversion from traditional manual operations. These five systems are: (1) manual system, (2) punch card accounting machine circulation system, (3) small scale control system, (4) large scale control system, and (5) on-line control system. Author

N67-32172# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
HIGH SPEED DIGITAL FILTERING BY CONVOLUTION APPROXIMATION Technical Report, Jan. 1964–Jun. 1966
E. B. Weis, Jr. Feb. 1967 21 p refs
(AMRL-TR-66-140; AD-652856) CFSTI: HC $3.00/MF $0.65

This report discusses a technique for digital filtering by convolution approximation which is an acceptable compromise between accuracy and speed. This technique is applicable where high accuracy is not necessary and where a digital computer with elaborate processing capability is not available. Most requirements for digital filtering can be developed in terms of the approximations suggested in this report. By casting the required filter in a form that is most amenable to numerical computation, the accuracy of approximation is maximized. If power-of-two accuracy is insufficient there is a continuous tradeoff between accuracy and speed which involves range division and more bits in the approximation. Author (TAB)

N67-32232# Joint Publications Research Service, Washington, D. C.
THE PROBLEM OF LINEAR PROGRAMMING FOR A GROUP OF PERMUTATIONS AND ITS APPLICATION IN OPTIMIZATION OF CODES

A. V. Krushevskiy *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 181–188 refs (See N67-32222 18-07)

A linear programming problem for a group of permutations is analyzed to find an optimal method of establishing the correspondence between messages and code combinations. Necessary and sufficient conditions of the extreme were located for solving the problem, and an algorithm was suggested, based on the necessary condition of the linear form extrema, which is easily programmed for digital computers. However the problem cannot be reduced to an ordinary linear programming problem. Mathematical descriptions of the problem are analyzed. The problem is then applied to finding a code giving the minimum mean decoding error. R.N.A.

N67-32234# Joint Publications Research Service, Washington, D. C.

SOME TRENDS IN THE DEVELOPMENT OF ALGORITHMIC STRUCTURES OF COMPUTERS

V. M. Glushkov and Z. L. Rabinovich *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 209–222 refs (See N67-32222 18-07)

Two trends in the development of algorithmic structures of mathematical digital machines are discussed. The first consists of the creation of complex super high speed devices which can perform a number of calculations simultaneously and are well suited for solving both ordinary and unique problems. The second trend is in the development and improvement of internal machine languages. The basic problems in developing algorithmic structures of computers are illustrated. An analysis is also made of problems involved in improving internal languages with the goal of making them closer to the programming languages. R.N.A.

N67-32313# Connecticut Univ., Storrs. General Dynamics Corp., Groton, Conn.

EXPERIMENTAL INVESTIGATIONS OF MAN-MACHINE PROCESSING OF INFORMATION. VOLUME I. AUGUST 1964–JUNE 1966

Herbert M. Kaufman, Robert M. Levy, Taylor L. Booth, Robert M. Glorioso, James R. Walter et al Groton, Conn., Gen. Dyn. Corp., Jun. 1966 169 p ref Prepared for Gen. Dyn. Corp.

(Contract Nonr-2512(00))

(U417-66-037; AD-653278) CFSTI: HC $3.00/MF $0.65

An experimental program to determine the capabilities of a man-computer system in processing target-in-noise displays is described. A general detection model, based on digital processing and a time varying operator display of the type found in sonar systems, is discussed. The theoretical effects of a number of detection model parameters are analyzed and their implications for the human operator explored. An experimental study of human operator processing of simulated Time-Bearing data under varying signal to noise ratios (S/N) and clipping thresholds (T) are described. Results indicate that human operators can maintain a consistently high detection performance level over the range of S/N and T studied. Performance, as measured by the number of trials to reach a decision, follows the theoretical optimum predicted by analytical studies. Author (TAB)

N67-32473# Military Academy, West Point, N. Y. Dept. of Electricity.

A PRAGMATIC FIRST LOOK AT DIAGNOSTIC PROGRAMMING FOR DIGITAL COMPUTERS

Philip H. Enslow, Jr. and Alan B. Salisbury May 1967 66 p refs

(Elec-67-3; AD-652730) CFSTI: HC $3.00/MF $0.65

A brief survey of diagnostic programming for digital computers. The purposes and organization of the program are covered as well as many of the problems attendant to their preparation. Various techniques that have been used to overcome these are discussed with emphasis on those that are practical (at least from the point of view of effort required) and those that have seen wide use. The primary purpose of this paper is to fully define the nature of the problem and the special considerations involved. Most of the discussion is fully applicable to both commercial and military equipment. Author (TAB)

N67-32483# Marine Engineering Lab., Annapolis, Md.

A GENERAL DIGITAL COMPUTER PROGRAM, CODAT, FOR SOLVING NOISE TRANSMISSION PROBLEMS

David R. Jordan Mar. 1967 71 p refs

(MEL-548/66; AD-653294) CFSTI: HC $3.00/MF $0.65

A digital computer program was developed for use in the study of acoustic noise transmission in machinery systems aboard Navy ships. The program interprets a list of three digit code numbers as mathematical and data input/output operations. The computations are done for complex variables, and both single elements and matrices can be manipulated with ease. The instructions may be given to the computer at a rate of 24 per card instead of 1 per card, thereby greatly reducing key punch time. Since there are relatively few code numbers, their use can be quickly mastered by persons unfamiliar with computer languages. Author (TAB)

N67-32605# RAND Corp., Santa Monica, Calif.

SOVIET CYBERNETICS: RECENT NEWS ITEMS, NO. 3

Wade B. Holland, ed. Apr. 1967 72 p refs

(P-3600/3; AD-650944)

CONTENTS:

1. SOVIET RESEARCH IN AUTOMATIC CHARACTER RECOGNITION: A SURVEY OF ORGANIZATIONS P. L. Stephan p 5–16 refs (See N67-32606 18-08)

2. AUTOMATIC TEXT READING M. L. Avrukh p 17–24 refs (See N67-32607 18-08)

3. MORE ON THE BESM-6 COMPUTER W. Holland p 25–34 refs (See N67-32608 18-08)

4. ADDITION TO THE BESM DYNASTY A. Dorodnitsyn p 35–38 refs (See N67-32609 18-08)

5. TYPE-Z MEMORIES P. L. Stephan p 39–42 refs (See N67-32610 18-08)

6. DESIGNING MAGNETIC ELEMENTS AND COMPUTER UNITS E. P. Balashov p 43–48 (See N67-32611 18-08)

7. NOT JUST ON A PUBLIC BASIS P. Lachugin p 49–51

8. APPLICATION OF ELECTRONIC COMPUTERS IN PRODUCTION CONTROL p 53–56 (See N67-32612 18-08)

9. REDUNDANCY IN INFORMATION SYSTEM (SYMPOSIUM IN LENINGRAD) N. A. Zhaleznov and M. B. Ignat'ev p 57–64 (See N67-32613 18-08)

10. THE COMPUTER BECOMES "MORE INTELLIGENT" A. Kronrod p 65–69 (See N67-32614 18-08)

11. EVOLUTION OF THE DEVELOPMENT OF DIGITAL ELECTRONIC COMPUTERS V. Pronin p 70–74 (See N67-32615 18-08)

12. ARTICLES AND PHOTOGRAPHS IN THE SOVIET PRESS p 75–86

N67-32606# RAND Corp., Santa Monica, Calif.

SOVIET RESEARCH IN AUTOMATIC CHARACTER RECOGNITION: A SURVEY OF ORGANIZATIONS

Patricia L. Stephan *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 5–16 refs (See N67-32605 18-08)

A brief survey is made of some of the Soviet organizations working in the area of character recognition and automatic text reading. It is based primarily on Soviet books rather than journals, with primary attention being given to material heretofore untranslated. The emphasis is on hardware rather than theory or methodology. Author

N67-32607# RAND Corp., Santa Monica, Calif.
AUTOMATIC TEXT READING
M. L. Avrukh *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 17–24 refs Transl. into ENGLISH from the book "Kompleksnaya Mekhanizatsiya i Avtomatizatsiya Protsessov Obrabotki. Poiska, Vydachi i Peredachi Na Rasstoyanie Nauchno-Tekhnicheskoj Informatsii" (Moscow), 1966 p 357–369 (See N67-32605 18-08)

Two trends in the development of automatic text reading devices are becoming apparent. The first is towards research into methods of solving the problem of recognizing any kind of characters, including handwriting. The basic approach is to create either a teaching system or a program for teaching recognition to computers. The second trend is concerned with solving the limited problem of automatic text reading of a specific type face in order to develop specalized reading automata designed for use in specific situations. In this area, a digital reader with an optical read head has been developed. The reader compares the pattern under investigation against a set of fixed image-field regions which yield invariant descriptions of patterns in binary or any other coding system. The reader uses ferrite matrices in the storage unit, ferrite-diode modules for all logic circuits, and transistor amplifiers for signal amplification. Advantages and deficiencies of the device are discussed along with some of its operating characteristics. R.N.A.

N67-32608# RAND Corp., Santa Monica, Calif.
MORE ON THE BESM-6 COMPUTER
Wade Holland *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 25–34 refs (See N67-32605 18-08)

The BESM-6 is the fastest known Soviet computer. Operating at one million operations per second, it can handle the computation of Fresnel's integral 55 times faster than the BESM-2. The BESM-6 located at the Moscow Computer Center will be used by biochemists to investigate structures of living organisms, by transportation experts to compile rational loading plans, by hydrologists to compute water flows during the construction of hydroelectric power dams, by industrial plant designers, and by physicists to determine particle deflections in a proton synchrotron. The BESM-6 located at the Novosibirsk Computer Center is being operated in conjunction with an on-line M-20 computer equipped with an Alpha compiler, through which all input for the BESM-6 is fed and converted to BESM-6 code. Consideration is being given to doubling the Novosibirsk BESM-6 core to 64K works, and to time sharing system, perhaps in conjunction with a Minsk-22 computer. The Novosibirsk machine uses eight memory drums at transfer rates of 20 microsec/work and a 20 msec revolution rate. Tape transfer rates are 40,000 bytes/sec with 10-bit bytes. Only one printer, operating at 340 lines/min, is used. R.N.A.

N67-32609# RAND Corp., Santa Monica, Calif.
ADDITION TO THE BESM DYNASTY
A. Dorodnitsyn *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 35–38 refs Transl. into ENGLISH from Izv. (Moscow), 3 Feb. 1967 p 3 (See N67-32605 18-08)

The main features of the high speed BESM-6 computer are described. The computer's machine time is reduced by overlapping the operation of its various components through the use of a special dispatcher program. This program makes it possible to solve several problems simultaneously and at the same time to fill in time gaps. The program also simplified control of the machine so that problems can be solved and debugged from different and even remotely located consoles. The BESM-6 uses a buffered memory which is a set of registers located between the main memory and the arithmetic unit. The most necessary and most frequently used results are stored in this set longer than other results. Information extracted from a cell in the buffered memory is returned to its previous place but as if it were regenerated information. The buffered memroy results in increased machine speed and relieves the programmers of the difficult problem of how to store intermediate results in the ultrafast memory. R.N.A.

N67-32610# RAND Corp., Santa Monica, Calif.
TYPE-Z MEMORIES
Patricia L. Stephan *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 39–42 refs (See N67-32605 18-08)

Several references and excerpts from Soviet literature are presented which indicate precisely how the type-Z core-store memories work. The type-Z memories are shown to be no different from what the West calls linear selection memories. R.N.A.

N67-32611# RAND Corp., Santa Monica, Calif.
DESIGNING MAGNETIC ELEMENTS AND COMPUTER UNITS
E. P. Balashov *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 43–48 Transl. into ENGLISH of the book "Proektirovanie Magnitnykh Elementov i Ustrojstv Elektronnykh Vychislitel'nykh Mashin" Moscow, Izd., Vysshaya Shkola 1966 p 251–253 (See N67-32605 18-08)

The design and operation of the linear selection type ferrite memory unit are described. The discussion seems to indicate that the linear selection memories are the same as type-Z memories. R.N.A.

N67-32612# RAND Corp., Santa Monica, Calif.
APPLICATION OF ELECTRONIC COMPUTERS IN PRODUCTION CONTROL
In its Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 53–56 Transl. into ENGLISH from the book "Primenenie Elektronno-Vychislitel'nykh Mashin V Upravlenii Proizvodstvom" Moscow, Izd. Ekonomika 1966 p 45–46, 48, 181, 184, 323–325 (See N67-32605 18-08)

A brief description of computer application to production control in Soviet industrial plants and computer centers is presented. Tentative technical specifications for computers in these two applications are tabulated. R.N.A.

N67-32613# RAND Corp., Santa Monica, Calif.
REDUNDANCY IN INFORMATION SYSTEMS (SYMPOSIUM IN LENINGRAD) [IZBYTOCHNOST V INFORMATIONNYKH SISTEMAKH (SIMPOZIUM V LENINGRADE)]
N. A. Zheleznov and M. B. Ignat'ev *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 57–63 Transl. into ENGLISH from Vestn. Akad. Nauk SSSR (Moscow), no. 10, 1966 p 100–102 (See N67-32605 18-08)

The proceedings of a symposium on redundancy in information systems are summarized along with papers and reports that were presented. The topics covered included redundancy in algorithms and structures, redundancy in media and microelectronic circuits, theory of correcting codes, redundancy of coding in communication channels and digital computers, intracircuit redundant coding, sequential decoding and combinational methods, direct methods of structural redundancy, control and the man-machine problem, redundancy in adaptive automatic control systems, redundancy in logic circuits, and informational evaluations of systems with redundancy. R.N.A.

N67-32614# RAND Corp., Santa Monica, Calif.
THE COMPUTER BECOMES "MORE INTELLIGENT" [MASHINA STANOVITSYA "UMNEE"]
A. Kronrod *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 65–69 Transl. into ENGLISH from Izv. (Moscow), 15 Mar. 1967 p 3 (See N67-32605 18-08)

Problems in heuristic programming concerned with low computer speeds, small memory sizes, and machine sorting of a tremendous number of items are discussed. Efforts to program

simple games have resulted in methods which yield a ten-million-fold acceleration of the sorting process. Research efforts are concentrating on the acceleration of direct sorting, the discovery of algorithms which bypass examination of obviously unprofitable paths, and the intelligent organization of the recording and processing of information. Future developments and applications of heuristic programming are briefly mentioned. A comparison of Soviet and American achievements in the field shows that the Soviets are ahead in the problem of machine pattern recognition and medical diagnostics, abreast in chess programming, and behind in equipping heuristic programming projects with computer hardware. R.N.A.

N67-32615# RAND Corp., Santa Monica, Calif.
EVOLUTION OF THE DEVELOPMENT OF DIGITAL ELECTRONIC COMPUTERS [RAZVITIE RAZRABOTOK TSIFROVYKH ELEKTRONNYKH VYCHISLITEL'NYKH MASHIN]
V. Pronin *In its* Soviet Cybernetics: Recent News Items, No. 3 Apr. 1967 p 70–74 Transl. into ENGLISH from the book "Primenenie Elektronno-Vychislitel'nykh Mashin v Upravlenii Proizvodstvom" Moscow, Izd. Ekonomika, 1966 p 382–335 (See N67-32605 18-09)

Tabular information is presented which shows the evolutionary development of several typical Soviet and U.S. computers, compares their storage units and operating features, and analyzes the increase in their programming difficulty. R.N.A.

N67-32675# Electronic Systems Div., Bedford, Mass. Technical Requirements and Standards Office.
AIR FORCE CONCEPTS FOR THE TECHNICAL CONTROL AND DESIGN VERIFICATION OF COMPUTER PROGRAMS
M. S. Pilgian and J. L. Pokorney Apr. 1967 18 p refs
(ESD-TR-67-67; AD-652209) CFSTI: HC $3.00/MF $0.65

The paper presents Air Force developed concepts for technical control and design verification of computer programs. Starting with the definition of a computer as a deliverable contract end item requiring a design and development effort, management procedures for controlling the design and development process are explained. Technical control of computer program design through periodic design reviews is outlined and test concepts for verification of computer program performance are presented. The techniques discussed are based on an exchange of technical information between the contractor and the procuring agency at a series of discrete milestones throughout the design and development process. The milestones, including design reviews, qualification testing, etc., are described and the relationship of these milestones to the design and development of a computer-based system is illustrated. The techniques are directly applicable to any large computer-based system whether it be military or commercial and they can be easily tailored to fit a small computer system. Author (TAB)

N67-32986# Navy Electronics Lab., San Diego, Calif.
A NELIAC COMPILER FOR THE HONEYWELL DDP 24 COMPUTER
J. F. Kohne, Jr. 8 Feb. 1967 131 p refs
(NEL-1438; AD-652367) CFSTI: HC $3.00/MF $0.65

Supplements a compiler for the CDC 924-A computer to enable interchange of programs between NEL and NRL antenna sites. Using the report, a programmer can learn to write Neliac programs for the DDP 24 computer without other reference material. Source codes, load and run instructions, and diagnostics are appended. Author (TAB)

N67-32988# Westinghouse Electric Corp., Baltimore, Md. Surface Div.
SELF-REPAIR TECHNIQUES INVESTIGATION Quarterly Report, 1 Dec. 1966–28 Feb. 1967
Frank B. Cole, Ralph M. Heller, and S. E. Zimmerman Jun. 1967 97 p refs
(Contract DA-28-043-AMC-02343(E))
(ECOM-02343-3; QR-3; Rept.-3; AD-653158) CFSTI: HC $3.00/MF $0.65

The report describes a set of techniques which can be used to design and construct self-repairing digital systems via spare parts switching. A discussion is presented of reliability results obtained from simulation of different switching strategies. A description of the proposed self-repair demonstration model computer is given with its associated fault detecting and locating techniques applied to each section of the computer. The appendix of this report is devoted entirely to techniques of self-repair in memory system via coding and in conjunction with spare switching. Author (TAB)

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-31507# General Electric Co., Syracuse, N. Y. Electronics Lab.
THE NET-1 COMPUTER PROGRAM AND ITS USE
Sep. 1966 37 p
(Doc.-R66ELS-97)

The NET-1 computer program is a generalized network analysis program used to simulate electronic circuits containing passive elements such as resistors, inductors, capacitors, and such mutual inductance and active devices as diodes and transistors. This report describes the setup procedure necessary for using the program on the 7094 computer and gives additionally two circuit analyses. Explained are also the steps necessary to restart a solution, to update the program tape, and to update the library tape. K.W.

N67-31510*# Atomics International, Canoga Park, Calif.
INVESTIGATION OF SUPERCURRENT INSTABILITIES IN TYPE II SUPERCONDUCTORS Final Report
17 May 1967 60 p refs
(Contract NAS8-20552)
(NASA-CR-86651; AI-67-83) CSCL 09A

The study of instabilities in superconductors is reported. The question of supercurrent capacity has been attacked experimentally. A strong correlation between current capacity and a metastable phase has been found. A theoretical investigation shows that the same thermodynamic nonequilibrium situation that gives rise to superconducting transport currents in the mixed state, which is generally referred to as flux pinning, results in instabilities of the magnetic flux structure. A distinction is made between limited instabilities that are self stopping, and localized events and runaway instabilities that have a catastrophic character disrupting the superconducting transport qualities of the specimen. These instabilities are also called flux jumps. Formulas are given to calculate the conditions for flux jumping for the simplest geometry; the influence of heat diffusion is crucial and makes accurate calculations very difficult. By contrast the criterion for stability is comparatively simple, containing only the specific heat and the temperature dependence of flux pinning. The study clearly shows how to prevent instabilities altogether by choosing materials which, over a limited temperature range, increase the flux pinning strength with increasing temperature. Author

N67-31515*# Di/An Controls, Inc., Boston, Mass.
LOW MAGNETIC FIELD AEROSPACE MEMORY Final Report
Marvin Mason 8 Jun. 1967 54 p
(Contract NAS5-9084)
(NASA-CR-86657) CSCL 09C

An aerospace memory which is a random-access coincident-current memory system that has a capacity of 512 two-bit words is described. The memory was developed to yield a very low operating power requirement and to produce a very low external magnetic field. In design and construction of this memory several techniques were used including: use of microminiature components and integrated circuits, use of nonmagnetic materials for minimal interference with satellite experiments, power-enabling techniques to reduce the operating power consumption, and complementary transistor circuit designs to reduce standby power. The memory is described with respect to its developmental history, test procedures and results, packaging, reliability, components, environmental requirements, size, and weight. S.P.

N67-31522# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
A CONSTANT BANDWIDTH, WIDE RANGE, TRANSISTORIZED LOGARITHMIC AMPLIFIER
Francis W. Hopwood 30 Mar. 1967 95 p refs
(Contract AF 19(628)-4050)
(SR-294(E); AFCRL-67-0188; AD-650894) CFSTI: HC $3.00/MF $0.65

An analysis of the breakpoint conditions necessary to form a constant bandwidth, tuned radio frequency, piecewise logarithmic amplifier is presented. The amplifier uses DC feedback rather than saturation or bias control techniques and the logarithmic transfer function is essentially independent of temperature and transistor parameters. The suitability of the device for pulse operation is considered, along with the effects of low frequency and high frequency modulation, and of operation at frequencies other than resonance. Author (TAB)

N67-31562*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PROCEEDINGS OF SECOND NASA MICROELECTRONICS SYMPOSIUM
Jun. 1967 557 p refs Symp. held at Greenbelt, Md., 19–22 Sep. 1966
(NASA-TM-X-55834; X-722-67-252) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Symposium papers on the application of microelectronics to NASA Space Program. For individual titles see N67-31563–N67-31605.

N67-31563*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GODDARD SPACE FLIGHT CENTER MICROELECTRONICS PROGRAM
J. C. Lyons and D. R. Dargo *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 1–5 (See N67-31562 18-09)

Reviewed are in-house research and development programs in microelectronics which focus on process and circuit development. Process studies which are described include studies of diffusion from gaseous sources; dielectric isolation; photoengraving techniques; a process for the fabrication of stable and P-channel metal oxide semiconductor field effect transistors; silicon nitride insulated gate field effect transistors; evaporated silicon resistors; surface passivation; and pyrolytic oxides. Circuits and devices described include a low signal transistor which was fabricated as a test vehicle for the evaluation of diffusion processes; a thirteen-input diode or gate which will be used on the statistics computer in the IMP-F spacecraft; a four-by-four diode matrix which is being used in an advanced OGO experiment to commutate pulses with rise time of 20 nanoseconds; a ten stage ring counter which utilizes all of the techniques available for triple diffusion circuitry, including MOS capacitors; and a two-bit MOS accumulator. S.C.W.

N67-31564*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LANGLEY RESEARCH CENTER MICROELECTRONICS PROGRAM
C. Husson *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 7–14 (See N67-31562 18-09)

Described are Langley Research Center (LRC) research and development programs in microelectronics, the state-of-the-art of microelectronics at LRC, and studies of materials for peripheral devices. Microelectronic investigations and developments are in three basic categories: systems, circuits and devices, and materials and components. Research efforts are primarily concerned with bulk monocrystalline, polycrystalline, and amorphous materials; studies of thick films; and the development and design of bulk materials. Studies focusing on the development of system and circuit prototypes for experimental payloads are being continued for the fiscal year 1967. Voltage controlled oscillators with very small constant bandwidths are under development. Completion of the beam lead matrix interconnectors is expected to satisfy many of the future payload instrumentation requirements. Although LRC has not yet converted to S-band telemetry, microelectronics applications are being considered and will be pursued after completion of a 3-watt UHF/FM transmitter. Microminiature thermistor bolometers are being investigated to correlate material behavior, processing, device performance, and system requirements. S.C.W.

N67-31565*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MARSHALL SPACE FLIGHT CENTER MICROELECTRONICS PROGRAM
J. C. Taylor *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 15–18 (See N67-31562 18-09)

A generalized discussion concerning the background, managerial philosophy, and implementation of the microelectronics program at MSFC is presented. The objective of the program is to increase reliability and flexibility and reduce the cost of electronic systems of Saturn vehicles and Apollo application programs within the Center's responsibility. The effort is MSFC and NASA mission-oriented to identify areas that require fundamental research, technological advancement, and hardware implementation in support of mainstream responsibilities. The importance of supporting research as an integral part of the overall plan, along with areas of competency, is also described. Author

N67-31566*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
STUDY OF METALLURGICAL PROBLEMS RELATED TO MICROELECTRONIC RELIABILITY
R. P. Beatty and J. E. Cline *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 19–31 refs (See N67-31562 18-09)

As part of a long-range effort to improve aerospace electronic component reliability, a study was undertaken to develop new metallurgical techniques for analysis of microelectronic device structures. The metallurgical problems investigated included interconnections, metal–semiconductor contacts, intermetallic compound formation, and thin-film process control. The instrumentation utilized for this study is briefly described. An electron probe microanalyser was used to scan the sample with a finely focused beam of electrons and to obtain information from the generated characteristic X-ray spectra, back-scattered electrons, secondary electrons, or specimen current. The gold-molybdenum metallization on integrated circuits was examined to determine changes in the microstructure occurring during various heat treatments. An X-ray spectrometric method was developed for

measurement of the thickness of aluminum films on silicon slices, affording improved control of the metallization process. A measurement accuracy of ±6 angstroms for very thin aluminum layers has been achieved. Author

N67-31567*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FABRICATION OF SILICON DEVICES BY ION IMPLANTATION
C. E. Winkler *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 33–39 (See N67-31562 18-09)

Research focusing on the development of ion implantation techniques for use in the fabrication of automatic transistors and integrated circuits; is reported. Specifically, the study involves the use of energy beams in the fabrication of semiconductor (silicon) devices, and emphasis is placed on techniques to eliminate the several photoengraving steps now prevalent in the conventional planar process. Main components of the implantation apparatus currently being used are described as well as characteristics of an ideal ion implantation technique for the production of transistors and integrated circuits. The implantation technique has been shown to satisfy criteria concerned with device fabrication by its successful use in the production of solar cells and radiation detectors. Work has progressed on a lens system and ion optical techniques compatible with an existing 400 kev accelerator and capable of resolution in the micron range. The basic design concept of the lens has been aimed at future versions capable of economic production devices. A relatively large maximum aperture was chosen to give the lens reasonable versatility. An automated high resolution implantation technique is illustrated, and advantages foreseen for the ion beam process in the production of transistors and integrated circuits are discussed. S.C.W.

N67-31568*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THIN-FILM MICROCIRCUIT DEVELOPMENT AT MARSHALL SPACE FLIGHT CENTER
G. D. Adams, S. V. Caruso, L. L. Folsom, R. F. deHaye, and G. L. Filip *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 41–58 refs (See N67-31562 18-09)

To meet the need for smaller electronic circuitry as a means of reducing weight in space vehicles, a thin-film microcircuit program was initiated at Marshall Space Flight Center (MSFC) in 1960. A brief history of this program and progress on each task to date are discussed, including facilities and equipment requirements and cost. The levels of past and present technology at MSFC are compared. Microcircuit capabilities, tolerances, and limitations are enumerated; and new equipment, methods, and techniques are summarized briefly. Author

N67-31569*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A NEW THIN-FILM APPARATUS FOR DEPOSITING INDUCTION DEVICES AND LC CIRCUITS
G. D. Adams *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 59–66 (See N67-31562 18-09)

A new apparatus has been designed and built to provide a method for depositing thin-film inductors, transformers, and LC circuits. This device and its application show promise of providing inductance in the range of several millihenries per square cm. A means is provided for making transformers with center taps. This paper describes a method of depositing distributive parameter LC circuits as a single device and explains construction and operation of the mechanism along with a number of possible modifications. Also discussed is a method of using the apparatus to deposit high-value capacitors. Author

N67-31570*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AN IMPROVED SPATTERPROOF VACUUM EVAPORATION SOURCE
G. D. Adams *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 67–70 refs (See N67-31562 18-09)

This report presents a new design concept for an improved spatterproof vacuum evaporation source for use in depositing thin solid films on a substrate. Construction details designed to prevent emission of high velocity solid particles that would damage the deposited film are described and illustrated. Simplicity and economy of construction and modest operating power requirements, as compared with presently available sources, are also discussed. This design has been proven in production use. Author

N67-31571*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A NEW THIN-FILM MICROCIRCUIT DEPOSITION MECHANISM
G. D. Adams and G. L. Filip *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 71–81 (See N67-31562 18-09)

Described is a new thin film circuit deposition unit which was designed and built to handle six 5 by 5-cm substrates, six masks, and 12 sources. The moving parts of the indexing mechanism have been reduced to a single, jam proof moving part. Moving electrical and mechanical motion feedthroughs have been effectively reduced to a single mechanical feedthrough. Precision indexing has been established in three planes. The unit is simple in construction and easy to adjust and clean. Effective baffling is provided to minimize cross contamination of source materials. Rotational motion is provided in either direction and any substrate, mask, or source combination can be obtained in a single motion. Source-to-substrate distance is long and can be easily shortened, if desired, by extending the source terminals. Provision is made for two large sources in each chamber. Loading and unloading the unit is made using a quick release substrate holder and by the provision of adequate space between the substrate carrier plate and the mask holding plate. High current sliding contacts have been eliminated. Positive resistance monitor contacts which are free from contamination are provided. The unit is completely integrated and may be used in any vacuum system without modification by use of an overhanging vacuum chamber. The unit has been proven in production. S.C.W.

N67-31573*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
PROPERTIES OF VACUUM-DEPOSITED THIN-FILM NICHROME RESISTORS
S. V. Caruso and R. F. deHaye *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 101–135 refs (See N67-31562 18-09)

A program which involved producing and testing microminiature circuits using nichrome resistors was carried out to determine the properties of vacuum-deposited nichrome thin-film resistors. This paper describes the methods and procedures used in the fabrication and testing, as well as the resulting characteristics, of these resistors. Test procedures and results are described for both aging and temperature coefficient of the resistance of the nichrome resistors. Author

N67-31574*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
MICROCIRCUIT MASKING TECHNIQUES
S. Gaudiano *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 137–153 refs (See N67-31562 18-09)

This paper discusses microcircuit masking, from the artwork preparation stage to the final circuit pattern. Emphasis is given to the importance of edge resolution and the physical limitations inherent in the various masking techniques. Fabrication methods of

each type are discussed, and detailed process data is included in the appendix for some of the types. Special masking techniques such as those used in thin-film transistor fabrication are also included. Author

N67-31575*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

SURFACE EFFECTS IN SEMICONDUCTORS DUE TO EVAPORATION TECHNIQUES

J. C. Lyons and D. R. Dargo *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 155–156 (See N67-31562 18-09)

Discussed are two phenomena which were observed during semiconductor device fabrication and which had a direct bearing on the operating characteristics of the device being fabricated. These phenomena were: (1) gain increases in a planar transistor after the silicon dioxide passivated surface has been coated with lead oxide and annealed; and (2) differences in gain and stability of transistors which had aluminum interconnections evaporated from an electron beam and from a tungsten filament. A method is proposed for overcoming problems of inversion layer formation in the P base of N-P-N devices encountered during the fabrication of silicon planar transistors. To eliminate the problem of positive charge phenomena (charges which attract to the surface any free electrons which might be in the P material, thus causing a shallow N-inversion layer), it is suggested that oxygen be added to the system by means of evaporating approximately 1,000 angstroms of lead oxide onto the silicon dioxide surface and annealing the wafer at 600°C. It has been found that this process increased the gains of low signal transistors from 20 to 200, with a base current of one microampere. It is further shown that in the fabrication of more stable metal oxide semiconductor field effect transistor devices, aluminum interconnections should be made by means of an electron beam evaporation rather than a filament evaporation. Results indicate that electron beam evaporation simplifies the fabrication of bipolar integrated circuits, while high-gain and low-leakage characteristics are retained. S.C.W.

N67-31576*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE PROCESSING OF SCREENED RESISTORS ON CERAMIC SUBSTRATES

R. L. Stermer, Jr. *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 157–165 refs (See N67-31562 18-09)

Experimentation with a small pilot process for the fabrication of screened circuits on alumina substrate revealed that deposition blooming was nearly independent of deposition area from 0.030-inch to 0.050-inch line width. It further showed that minimum resistance change under electrical power load at atmospheric and vacuum pressures could be achieved with circuits fired at 1400°F on a belt moving through the curing oven at a rate of 1 inch per second. Thermal and mechanical shock testing showed that conservative applications of solder on contact points physically distributed on the substrate provided satisfactory physical integrity with no measurable resistance change during testing. These results indicate that a pilot process has been established with the capability of producing screened circuits having excellent reproducible characteristics within acceptable limits. Author

N67-31577*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A THICK-FILM, INSULATED GATE FIELD EFFECT TRANSISTOR

R. L. Stermer, Jr. *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 167–171 (See N67-31562 18-09)

A thick film, insulated gate field effect transistor is being developed to utilize the simple processing technology of thick film circuits. At the present state of development, significant characteristics have been obtained in thick film transistors. Data showing high transconductance, high output impedance, and excellent stability characteristics are presented and processing technology discussed. Author

N67-31578*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

COMPATIBLE THIN-FILM TRANSISTORS

Frank Baiamonte *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 173–184 refs (See N67-31562 18-09)

Several approaches have been attempted to obtain thin-film transistors which are compatible with passive components. Results of recent efforts in developing the thin-film, field effect triode are described. Device geometry, as pertains to both performance and process limitations, is discussed from practical and theoretical standpoints. Author

N67-31579*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

OPTICAL MEMORY WITH FERRIMAGNETIC STORAGE ELEMENTS

G. A. Bailey *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 185–191 (See N67-31562 18-09)

This report summarizes results of an effort to fabricate a magnetooptic memory. The scope of work included efforts to produce a material that would operate without compensation at room temperature. The material was evaluated to determine its magnetic, optical, and thermal properties such that the design of the memory might be optimized. To demonstrate the results of the experimentation a feasibility model was designed and fabricated. The storage element chosen was gadolinium iron garnet doped with aluminum. Information is written into the memory by simultaneously applying heat and a magnetic field to a spot. Since the coercivity of the material is temperature dependent, only the heated portion of the garnet is affected by the field. The readout signal is derived from the Faraday rotation of a polarized beam of light by the element. The state of magnetization of a region is determined by observing the direction of Faraday rotation. Author

N67-31580*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

RECENT DEVELOPMENTS IN THIN-FILM CAPACITORS

W. C. McGrady *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 193–206 refs (See N67-31562 18-09)

Dielectric theory and the state of the art of thin film capacitors are reviewed, and problems encountered when attempting to evaporate high dielectric constant materials are indicated. The materials discussed are inorganic compounds, many of which contain titanium. Since $BaTiO_3$ is typical of this class of materials, it is considered to illustrate inherent problems associated with its evaporation. Efforts of the MSC program in the field of high K materials research are detailed. Emphasized are studies focusing on the development of dielectric materials whose deposition processes are compatible with this fabrication of silicon active devices; a material whose dielectric constant is relatively constant over a wide temperature range; and ultimately the achievement of thin film capacitors whose physical and electrical characteristics represent an order of thin magnitude improvement over those presently available. Preliminary results show that: (1) the basic difficulty involved in the deposition of materials needed for capacitor dielectrics was one of stoichiometry; (2) flash and multisource evaporation appear to be the most promising deposition methods; (3) of the materials considered, the most promising appear to be a barium-lead zirconate mixture, potassium niobate, and sodium niobate. On the basis of these results it is surmised that compatibility with silicon integrated circuit processes is a prime requirement and unless compatible deposition processes can be found, there is little likelihood that specific capacitances greater than 1 $\mu f/in^2$ will ever be widely used. S.C.W.

N67-31581*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
CURRENT THIN-FILM APPLICATIONS
G. T. Lewis *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 207–219 (See N67-31562 18-09)

The present practical limitations of thin-film circuits are presented in terms of their application to the Apollo thin-film personal communication system under development. The system operates in the 300-Mc frequency range and imposes certain design requirements on thin-film devices which had not been considered previously. The design effort described includes research on thin-film field-effect transistors, metal-base transistors, high-frequency inductors, substrates, dielectrics, and high-permeability magnetic thin films. The concept of the personal communication system is described together with conclusions reached during the first phase of the development of the current thin-film version. Author

N67-31582*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
A HYBRID MICROELECTRONIC A-TO-D CONVERTER
D. M. Bergens *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 221–228 (See N67-31562 18-09)

A study designed to investigate the feasibility of using hybrid, thin film techniques to manufacture an analog-to-digital converter (ADC) suitable for spacecraft use; is reported. The converter consists of uncased monolithic digital circuits and transistors mounted on three thin film substrates which contain precision resistors and interconnections. The total volume of the three packaged substrates is 0.55 cubic inch, and their weight is less than two ounces. The ADC operates on the principle of successive approximation, quantizing the input voltage into an 8-bit binary number. The input voltage range is 0 to +3 volts. This range gives the unit a resolution of approximately 11.7 millivolts. The maximum bit quantization rate is about 400 kHz, or 20 microseconds per word. The power dissipation is about 900 milliwatts. A conversion accuracy of 0.5% has been achieved with the converter. Design, fabrication, and test results are discussed along with indicated problem areas, possible modifications, and improvements. S.C.W.

N67-31583*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PROTON-ACTUATED, SOLID-STATE SWITCH DEVELOPMENT
D. M. Bergens *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 229–235 refs (See N67-31562 18-09)

Described are two types of solid state switches with self-contained photon actuation which are under development. One switch is for the precision multiplexing of low voltage signals, and the other will be used at the outputs of a spacecraft command subsystem where complete electrical isolation is necessary for the prevention of ground loops. The switches utilize infrared radiation from a GaAs diode to turn on a phototransistor. The switches were designed to be encased in typical integrated circuit flat packages. The command isolation switch has an 8-input gate and diode driver circuit included in the package. Development, fabrication, test results, and problem areas are discussed. Author

N67-31584*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
DESENSITIZING OF MICROCIRCUITS TO VARIATIONS IN TEMPERATURE AND PRODUCTION SPREAD PHASE (III): COMPUTER AIDED SENSITIVITY ANALYSIS
W. F. Hartman and R. M. Carpenter *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 237–260 refs (See N67-31562 18-09)

An in-house research task was completed as part of a long range effort to establish design procedures for microcircuits in which the sensitivity of performance parameters to temperature variations is minimized. Representative examples from design practice are selected to develop a step-by-step procedure for design evaluation which focuses on: (1) selection of the equivalent circuit for computer-aided analysis; (2) coding of equivalent circuit for data processing; (3) describing computer derived sensitivity functions; and (4) determining optimum desensitized design configurations. Performance of fabricated circuits will then be compared with computer-predicted design specifications. Phase (III) reviews fundamentals of sensitivity analysis so that this report will be self-contained and useful to electrical engineers without any background in sensitivity analysis and computer-aided circuit design. A Fortran IV program is developed, which obtains a wide range of sensitivity functions from a coded input of an equivalent circuit. Several examples of increasing complexity are presented to illustrate the usefulness of the program as an aid in obtaining sensitivity functions in symbolic and numerical form. Author

N67-31585*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
DESENSITIZING OF MICROCIRCUITS TO VARIATIONS IN TEMPERATURE AND PRODUCTION SPREAD. PHASE IV: TOLERANCE IN PERFORMANCE CRITERIA DUE TO PRODUCTION SPREAD OF PARAMETERS
W. Rombalski and R. M. Carpenter *In its* Proc. of 2d NASA Microelectron. Symp Jun. 1967 p 261–268 refs (See N67-31562 18-09)

A computer program for tolerance analysis is established which uses as input data: (1) the topology of the equivalent circuit; (2) statistical distribution of each circuit parameter; and (3) desired performance criteria and desired sampling frequencies. The program obtains first the sensitivity matrix for the network. Next, the sensitivity matrix is weighed in terms of statistical distribution of each circuit parameter. The tolerance of the specified performance parameters of the circuit is then evaluated as a quadratic error due to the deviations by the weighed sensitivity matrix. The program provides: (1) tolerance in performance criteria at specified frequencies; (2) identification of components which most heavily contribute to fluctuations in performance; and (3) A format for desirable specifications of component tolerances, which is essential to computer oriented analysis. Examples of increasing complexity serve to demonstrate that the technique can be effectively used by reliability engineers without specialized knowledge in circuit design. Author

N67-31586*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
ADAPTATION OF MODELS FOR MINORITY-CARRIER DEVICES TO INTEGRATED CIRCUITS
A. S. Weitzenfeld and W. W. Happ *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 269–283 refs (See N67-31562 18-09)

Progress is reported on the initial phase of a continuing in-house research effort to examine alternative models of minority carrier devices for their usefulness in computer aided evaluation of integrated circuits. The minority carrier parameters, often referred to as the Linvill diffusance model, are investigated with a view to extending this approach to represent networks containing microcircuit elements. This model is to be compared with the conventional model based on networks containing controlled sources. Corresponding design specifications such as frequency response and sensitivity analysis, are then to be compared, so that the region of validity and the limitation of each model may be identified. Guidelines are to be developed for the explicit formulation of circuit design problems in terms of algorithms upon which the computer programs are based. Discrepancies between experimental and computed results are to be examined. The dual potential N and P type device, upon which the Linvill Model is based, requires re-examination as an extension of networks with a single type of

potential. The strategy selected to accomplish this is the extension of dichotomous algorithms to bi-potential systems. To make this account self-contained, dichotomous techniques will be reviewed, and an outline will be presented describing how dichotomous algorithms may be extended. Author

N67-31587*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

COMPLEMENTARY MOS-FET NAND GATE MODELING FOR COMPUTER-AIDED TRANSIENT ANALYSIS

M. E. Kaliski and J. A. Dumanian *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 285–289 refs (See N67-31562 18-09)

A nonlinear model of a field effect transistor is developed for performing a computer-aided transient analysis of a complementary MOS-FET, two input NAND gate. The model considers the source-to-substrate-offset voltage effect on the gate. The computer predicted performance is compared to experimental results. The procedure derived here is applicable to more complex MOS–FET circuits in which variations in source-to-substrate voltage exist. Author

N67-31588*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge Mass.

FLOWGRAPHS: DISPLAY TECHNIQUE FOR INTERACTIONS BETWEEN THERMAL AND ELECTRICAL DEVICE PARAMETERS

W. W. Happ *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 291–301 refs (See N67-31562 18-09)

This paper reports progress made on a continuing in-house research effort to examine the complex relationships between variables and parameters in microcircuits. Flowgraph analysis is used to provide evidence of the interactions under investigation. Flowgraphs describe relationships between thermal and electrical parameters of devices and associated circuits. In addition, flowgraphs permit a systematic investigation of a wide range of device phenomena, such as thermal stability, and are applied to temperature dependent parameter variations in transistors. Flowgraph analysis is used to evaluate design criteria for compensation of thermal effects by associated circuits, and flowgraph models serve to justify design limitations and design approximations based on thermal dependence. Author

N67-31589*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.

COMPUTER-ORIENTED MODELLING OF INTEGRATED CIRCUITS: ALGORITHMS FOR THE DICHOTOMOUS PRESENTATION OF ACTIVE NETWORKS

R. M. Carpenter and W. W. Happ *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 303–319 refs (See N67-31562 18-09)

Progress is reported on a research effort aimed at developing standardization and qualification procedures for integrated circuits through computer aided design evaluation. A compatible series of computer programs is developed for circuits with many components, typically 30–100. The programs are based on theorems for oriented, weighted graphs, and are intended to meet circuit design requirements which exceed the memory capacity of medium-size computers when programs based on node or mesh analysis are employed. Since these limitations become more severe as worst-case design, Monte-Carlo routines, and similar reliability techniques are introduced, the procedure developed is particularly useful to designers and analysts with access to a medium or desk size computer, or to a time-sharing outlet. The approach is based on the dichotomy entailed in the flowgraph associated with any active network. Algorithms are established for three purposes: (1) To dichotomize the network into voltage and current generators; (2) To examine separately each set and the associated system of controls interrelating both sets; and (3) To establish a flowgraph in terms of a unique dichotomous presentation for a given equivalent circuit. While the algorithms were developed for linear networks, the dichotomous procedures provide a less restricted approach. Author

N67-31590*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

MICROCIRCUIT APPLICATIONS IN THE APOLLO TV CAMERA

M. Engert *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 321–331 refs (See N67-31562 18-09)

Circuit design approaches to obtain 80% utilization of microcircuits in the Apollo TV camera are presented. A universal microcircuit breadboard functional block is described. Application problems are indicated along with final microcircuit design details. Certain aspects of the quality control and reliability programs, as applied to new microcircuit designs used in the camera, are discussed with emphasis on practical considerations. Author

N67-31592*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

PACKAGING FLAT-PACKS FOR SPACECRAFT APPLICATIONS

L. Katzin *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 347–358 (See N67-31562 18-09)

Four methods of interconnecting flat-packs are described. Three of them are well-known techniques. They are the multilayer board, laminated-comb, and magnet wire stick techniques. The fourth technique, the molded interconnect board, is a new technique just emerging from the experimental state. Advantages and disadvantages of each technique are described. Author

N67-31593*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

THE INTEGRATED-CIRCUIT CONTROL AND TIMING SYSTEM OF THE HIGH-ALTITUDE ROCKET-RADAR PROJECT

H. L. Friedman and R. H. White *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 359–377 (See N67-31562 18-09)

This report covers the work accomplished in designing an integrated circuit control and timing system used aboard the high altitude rocket radar launched at White Sands, New Mexico, USA on June 30, 1965, and May 1966. The system has been designed with basic integrated circuit modules which have been programmed in a particular manner for this project, but which are designed so that they can be programmed in many alternative configurations such as shift registers or counters of various lengths. The important points discussed are: the design of integrated digital circuits into programmable and functional three-dimensional modules; the voltage margins and noise sensitivity obtained; the use of a nonmagnetic interconnect material in welding; a clear encapsulation used for the modules; the unique method of integrated circuit packaging, and failures that have occurred in the integrated circuits on this project. A discussion of how the specific method of failure analysis has upgraded the integrated circuit manufacturer's state-of-the-art in his production methods is also presented. Also discussed is a high reliability integrated circuit inspection plan, which is not being used on the Mariner–Venus 1967 project to procure integrated circuits. Author

N67-31594*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

APPLICATIONS OF A COMBINED COUNTER/SHIFT REGISTER MODULE

R. A. Cliff *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 379–384 (See N67-31562 18-09)

Speculations about possible uses of complex integrated circuit modules are presented. A conceptual design of a counter/shift register module is described to illustrate what can be done once

complex integrated circuits become available. There are a counter input and a serial data input. Output data are in serial form also. Other than power supply and ground connections, only two more leads are required. One is for the shift clock, which causes the register to shift; the other is for a count/shift command, which converts the register from a counter to a shift register. Potential applications of the counter/shift register as spacecraft telemetry encoders and logarithmic compression are discussed. S.C.W.

N67-31595*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A MICROELECTRONIC DATA SYSTEM FOR WIND-TUNNEL RESEARCH
W. M. Moore and J. H. Schrader *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 385–394 (See N67-31562 18-09)

This paper describes the development of an analog data and digital command control system for research aircraft models to be tested in the transonic dynamic wind tunnel at Langley Research Center. Microelectronic circuits are employed in this instrumentation and control system which could not have been developed with discrete electronic components. The instrumentation employed in test models includes: (1) 20 microminiature subcarrier oscillators, (2) 20 complex signal conditioning units which employ hybrid thick film and integrated circuit microelectronics, and (3) a 30-channel command decoder constructed entirely from integrated circuits. The gain and offset for the 20 data channels can be remotely programmed. Artificial vibration and flutter can be introduced into the test model and controlled remotely by command, and there are provisions for maintaining angle of attack by a remote-control function. The microelectronic circuits and hardware that are used for these and other functions are described. Author

N67-31596*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
MAGNETIC OR INTEGRATED CIRCUITS: A COMPARATIVE ANALYSIS OF THEIR APPLICATION TO A MICROMETEOROID SENSOR SCANNING PROGRAM
L. A. Taylor *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 395–404 (See N67-31562 18-09)

A proposed experiment to obtain statistical data on micrometeoroid penetration rates in spacecraft structural materials containing 1 to 50 mils of aluminum requires the deployment of 6000–7000 square feet of sensor material during a 1- to 2-year period. The physical dimensions imposed by the thin sensor materials dictate the use of 1000 micrometeoroid pressure-cell sensors for this purpose. Instrumenting and scanning such numbers of sensors on a spacecraft with an 85-foot span poses formidable problems. For example, the amount of cable and electronics required to do so with conventional circuitry makes the task very difficult and affects reliability and power consumption. To alleviate this situation, a method of segmented data scanning was developed that permits direct entry of sensor data into a matrix of electronic devices which scan all sensor switches. The method has been implemented through the use of both integrated and magnetic circuit techniques. This paper compares the two techniques with regard to operation, power requirements, size and potential reliability. Some limitations of the integrated circuits employed are discussed, and areas for further development are suggested. Author

N67-31597*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
POWER INTEGRATED CIRCUITS IN THE SATURN SYSTEM
A. E. Willis *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 405–411 (See N67-31562 18-09)

This paper outlines the development of three individual circuits and the Saturn three-phase, 400-Hz static inverter. Author

N67-31598*# Jet Propulsion Lab., Calif. Inst. of Tech. Pasadena.
A TEMPORARY SYNCHRONOUS CLOCK SOURCE FOR SPINNING SPACECRAFT
G. Kunstman and D. K. Rubin *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 413–422 (See N67-31562 18-09)

A laboratory breadboard of a spaceborne synchronous clock pulse generator is described. The generator output may be used, following a short period of synchronization of spacecraft spin rate, to establish an accurate third reference axis for approximately 1-hour. This device can simplify the implementation required for arbitrary reorientation of the spacecraft spin axis. The design, operating characteristics, and physical difficulties during debugging are discussed. The difficulties encountered prompted the development of a flexible, low-priced breadboard technique including all necessary hardware. A thorough exposition of this technique is a major product of the paper. Author

N67-31599# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
EVALUATION OF SEMICONDUCTOR DEVICES USING THE SCANNING ELECTRON MICROSCOPE
G. Berryman and T. R. Edwards (Natl. Acad. of Sci.) *In its* Proc. of 2d NASA Microelectro. Symp. Jun. 1967 p 423–431 refs (See N67-31562 18-09)

Described is a scanning electron microscope which has been used as a research tool for investigating failure mechanisms in integrated circuits and other semiconductor devices. An immediate advantage of this type of microscope over the transmission or reflection type is its nondestructive, no-replica approach towards looking at surface topologies. Biological specimens with light metallic coatings are good examples of these facts. The grasshopper's knee is illustrated to show the good three-dimensional representation that can be obtained using this technique. As a demonstration of the micro-scan's flexibility to detect failures in semiconductor junctions, an optical view of a double-diffused n-p-n transistor is analyzed. In addition to applications pertaining to failure analysis, the instrument can be used to trace integrated circuit patterns on semiconductor chips. S.C.W.

N67-31600*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FAST SCAN INFRARED MICROSCOPE FOR IMPROVING MICROELECTRONIC DEVICE RELIABILITY
L. Hamiter *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 433–443 (See N67-31562 18-09)

A testing process is presented which uses infrared radiation to measure thermal and electromechanical aspects of elements of a circuit. This method evolved from the incapability of conventional test equipment and processes to measure these parameters, a limitation due mostly to the small size of the elements. A fast scan infrared microscope has been developed to implement infrared testing; its characteristics and capabilities are described. A study is still in progress to determine other abilities of infrared testing. Author

N67-31601*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
PHENOMENOLOGICAL STUDY OF RADIATION DAMAGE AND RECOVERY OF METAL–OXIDE FIELD EFFECT TRANSISTORS
R. L. Van Allen, V. D. Desai, and J. L. Wolfgang, Jr. *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 445–449 (See N67-31562 18-09)

Data for radiation damage by 1.5 Mev electrons to several types of MOSFETs (Metal-Oxide Semiconductor Field Effect Transistors) and the results of two annealing modes are presented. In the passive mode of annealing, completed in 15 to 20 hours, the data showed significant hardening effects. The active mode of annealing

yielded a quick recovery to the original threshold or better. In the passive mode of annealing, although the device was radiation hardening, the final gate threshold achieved was higher in comparison to the initial gate threshold. Author

N67-31602*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATING THE POTENTIAL RELIABILITY OF INTEGRATED CIRCUITS FROM PARAMETER DISTRIBUTIONS
H. B. Milteer *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 451–458 refs (See N67-31562 18-09)

This paper discusses distribution plots of electrical parameters as a means of investigating the potential reliability of integrated circuits. Data from the Lunar Orbiter project and various Government research programs are examined. Emphasis is placed on leakage current measurements and their conformance or nonconformance to a log normal distribution. The multiple slope log normal distribution is discussed in detail with relation to parts design, product improvements, and potential failure mechanisms. The effect of aging on integrated circuits is correlated with shifts in the electrical parameter distributions. Individual electrical parameters appear to drift almost randomly on the basic distribution curve. This phenomenon is used to show the inadequacy of present methods of power burn-in as a screening test. The concept is further used to describe the use of this type of data presentation in analyzing the results of environmental step-stress testing. The advantages and limitations of product capability testing, and of incorporating this approach into a qualification program for microelectronic devices are also discussed. Attention is devoted to the stresses which appear to be the most effective indicators of integrated-circuit weaknesses. Author

N67-31603*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A HIGH RELIABILITY SPECIFICATION FOR DIGITAL INTEGRATED CIRCUITS
J. W. Adolphsen and R. J. Wilkinson *In its* Proc. of 2d NASA Microelectron. Symp Jun. 1967 p 459–469 (See N67-31562 18-09)

This paper traces the circumstances leading to the writing of a high reliability specification for a specific family of digital integrated circuits. Various aspects and details of the specification are discussed which are different in total or in degree from other high reliability specifications. Both tangible and intangible (human engineering) factors were considered and incorporated. Particular emphasis is placed on visual inspection criteria. Varying degrees of failure analysis are called for and have proved to be a valuable source of failure mode information. Although in-system results of units delivered to this specification are limited at this time, available results are discussed. Comparative pricing with some devices built to other specifications is given. The specification itself is included as an appendix. Author

N67-31604*# Jet Propulsion Lab., Calif. Inst. of Tech. Pasadena.
DIGITAL MICROCIRCUIT STERILIZATION TEST PROGRAM
C. J. Marlett *In* NASA. Goddard Space Flight Center Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 507–517 (See N67-31562 18-09)

Several integrated circuits from various manufacturers were subjected to qualification tests consisting of heat sterilization, vibration, shock, acceleration, temperature cycling and operating long life. This paper discusses the relative merits of each as determined by these tests. The various environments, life test equipment designs, and automatic measurement equipment are described. The parameters, statistical analyses, and results are presented, along with detailed failure analyses of catastrophic and degradation failures. Author

N67-31605*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
MICROELECTRONICS ON ATS
R. L. Van Allen *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 519–528 refs (See N67-31562 18-09)

Described are reliability aspects, methods of handling, packaging, and general comments concerning the use of microelectronics in the Environmental Measurements Experiment (EME) encoder. The EME is the scientific experimental package scheduled to fly on each of the three major variations of the Applications Technology Satellite. Four complete encoders have been fabricated for EME of which three have been given qualification or acceptance tests. The total microelectronic device time totals more than 1,800,000 flat pack hours. Three of the systems were fabricated using flat packs with aluminum-gold interconnections. Most of the fourth system and spares were fabricated with devices having gold-gold bonds. In each encoder there are approximately three flat packs used for each transistor; however, in the entire EME package (including the power supply and command interface) transistors are used in nearly the same ratio as flat packs. There have been no transistor failures in any tests on the complete encoders; however, three flat packs have failed after submodules were assembled into a complete system. These three failures occurred during the encoder preacceptance tests. No failures have occurred during spacecraft qualification or acceptance testing. S.C.W.

N67-31655 International Computers and Tabulators, Ltd., London (England).
STEADY-STATE AND DYNAMIC CHARACTERISTIC VARIATIONS IN DIGITAL WALL-ATTACHMENT DEVICES
B. J. Steptoe 5 Jan. 1967 11 p Presented at the 2d Cranfield Fluidics Conf., Cambridge, England, 3–5 Jan. 1967
(B3)

Steady state tests on miniature OR/NOR and bistable wall-attachment elements are described. Results are given in the form of histograms of input and output pressure characteristics for batches of elements manufactured by the epoxy replication process. Power flow variations are also described. Switching characteristics of OR/NOR elements are described and differences between switch on and switch off delay are mentioned. An attempt is made to compare steady state and switching characteristics. A discussion of noise immunity is given, and specifications for elements are derived. It is concluded that epoxy replication is one method of achieving the close control of characteristics required for successful manufacture of fluidic integrated circuits. Author

N67-31819* Autonetics, Anaheim, Calif.
PROCESS TECHNIQUES STUDY OF INTEGRATED CIRCUITS Quarterly Report
J. E. Meinhard Feb. 1967 45 p refs
(Contract NAS12-4)
(NASA-CR-88628; QR-7; C5-1471.7/3111) CSCL 09A

Work efforts to obtain more quantitative information on the entrapment of hydrogen in grown silicon dioxide layers using tritium as a tracer and to seek evidence of its possible ionic mobility in a potential gradient are reported. Analysis of wafers from recent tritium experiments duplicating the conditions reported by Burgess and Fowkes failed to show any measurable beta activity. The differences of these and present results are explained. Thirty integrated circuits selected from three manufacturers were electrically characterized and the contained package ambients analyzed by mass spectrometry. Evidence from EPR absorption spectrometry of thermally grown oxides indicates that the presence of unpaired electron spins may be associated with prior HF treatments such as those used in chemical polishing of wafers or in window etching. EPR absorption of an aluminized oxide on silicon yielded a peak with a value of 2.0023 ± 0.0004. No impurities in excess of 1% by weight was found in these samples by microprobe analysis. Author

N67-31822*# Martin Co., Orlando, Fla.
ADVANCED CONTROL SIGNAL PROCESSOR MODULE DESIGN, FABRICATION, AND TEST, PHASE V Final Report
W. B. Towles Jun. 1967 36 p
(Contract NAS8-11684)
(NASA-CR-85972; OR-8874) CFSTI: HC $3.00/MF $0.65 CSCL 09A

This final report describes the design, fabrication, and test of the new Inverter module. A dynamic analysis revealed that relative module pin displacements were considerably lower than those measured in Phase III tests. RTV 615 and RTV 616 silicone rubbers were selected for conformal coating and CRP 241 epoxy was chosen as the encapsulant. A detailed description of thin film circuit fabrication, module assembly, and encapsulation is given. Author

N67-31845*# Westinghouse Electric Corp., Huntsville, Ala.
DEVELOPMENT OF MULTILAYER EPITAXY FOR HIGH RELIABILITY TRANSISTORS Final Report, Jul. 1966–Mar. 1967
P. M. Kisinko, T. C. New, F. G. Ernick, P. J. Kannam, M. H. Francombe et al Mar. 1967 86 p
(Contract NAS8-18125)
(NASA-CR-86638) CSCL 09A

The design and process technology employed to develop multilayer epitaxy for high reliability transistors is described. All of the devices generated were NPN transistors with epitaxially grown collector and base regions and diffused emitters. In order to determine the effect of various base widths and resistivities on switching speed and peak power capability, transistors rated at 30 amperes were designed, fabricated, and evaluated. The resulting information was used to establish conditions for the 100-ampere final samples. The epitaxial techniques employed yielded essentially defect-free material which is a requisite for large area, high power transistors. X-ray diffraction topographic studies were made to check the material perfection and to improve the processing. Author

N67-31882 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE ANALOG-TO-DIGITAL CONVERTER FOR 256-CHANNEL AMPLITUDE ANALYZER
R. Bayer 1966 19 p refs In POLISH; ENGLISH summary
(INR-769(III)E)

The analog-to-digital converter for 256-channel amplitude analyzer has been built. Its operation principle and characteristics are described. Some results of measurements are given. Author

N67-31886# Bolkow Entwicklungen K. G., Munich (West Germany).
AUTOMATIC RETRIEVAL OF THE CALIBRATION POINTS OF DATA TRANSFORMERS USING A PRESSURE IMPULSE TRANSMITTER [AUTOMATISCHE ERFASSUNG DER EICHPUNKTE VON MESSWERTWANDLERN MIT HILFE EINES DRUCKIMPULSGEBERS]
E. Binder *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 83–104 (See N67-31881 18-08)

Methods to convert physical measurements into electrical impulses are briefly presented and elements of an automatic transducer and digital transformer of pressure impulses are discussed. The automatic transducer is able to eliminate unwanted registrations and only presents measurement of desired value-pairs on punch tape. A digital computer, connected with the impulse pick-up, pressure sensors, correlates electronically all calibration points to a single precision measurement. Transl. by G.G.

N67-31988*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
THE DEVELOPMENT OF A MICROMINIATURE dc SIGNAL-CONDITIONING AMPLIFIER
Guss E. Wenzel Washington, NASA, Jul. 1967 61 p refs
(NASA-TN-D-4091) CFSTI: HC $3.00/MF $0.65 CSCL 09C

The purpose of this effort was to design and develop the basic circuitry for an integrated-circuit, direct-coupled amplifier that is stable with respect to time and temperature. The resulting amplifier will serve as a basic building block in a microminiature signal-conditioning system. The initial phase of this development has been successfully completed. The state of the art of signal-conditioning amplifiers has been definitely extended. It is now feasible to design and develop a space flight signal-conditioning system that will require only 2 to 3 percent of the power, weight, and volume requirements of the present signal-conditioning systems. The efforts of the first phase in the amplifier development are described. In addition to the design and manufacturing considerations, the test results are included. The performance is then compared with the specifications, and comments are made where applicable. Author

N67-31996# Hewlett-Packard Co., Palo Alto, Calif.
HEWLET–PACKARD JOURNAL, VOLUME 18, NO. 4
Dec. 1966 26 p refs

CONTENTS:

1. A NEW HIGH-PERFORMANCE 1.5 MHz TAPE RECORDER G. L. Ainsworth p 2–7 refs (See N67-31997 18-09)

2. A CURRENT PREAMPLIFIER FOR MAGNETIC TAPE PLAYBACK SYSTEMS A. B. Bergh p 8–9 (See N67-31998 18-09)

3. WIDEBAND CAVITY-TYPE COAXIAL FREQUENCY METERS S. F. Adam and A. S. Badger p 10–12 ref (See N67-31999 18-09)

4. SIMPLIFIED TECHNIQUE FOR EVALUATING DIODE RF PERFORMANCE B. Levine p 12–13 (See N67-32000 18-09)

5. SWEPT-FREQUENCY SWR MEASUREMENTS IN COAXIAL SYSTEMS S. F. Adam p 14–20 refs (See N67-32001 18-09)

N67-31997# Hewlett-Packard Co., Palo Alto, Calif.
A NEW HIGH-PERFORMANCE 1.5 MHz TAPE RECORDER
Gerald L. Ainsworth *In its* Hewlett-Packard J., Vol. 18, No. 4 Dec. 1966 p 2–7 refs (See N67-31996 17-09)

In the design approach used in the 1.5 MHz tape recording system, the reproduce head feeds a low impedance preamplifier which senses current rather than voltage. The result is said to be a signal-to-noise ratio of greater than 30 dB from 400 Hz to 1.5 MHz, and a greater design flexibility permitting lower system cost while maintaining high performance. Record circuitry includes a flux equalizing filter to compensate for high frequency losses in the record head; one bias oscillator is used for each set of seven channels in the system. To provide low distortion with a minimum number of components, reproduce amplifiers use a large amount of feedback around all the transistors. For tape transport, highly-damped synchronous motors drive the capstan, eliminating the need for complex servo systems. Decreased noise and wider bandwidth are cited as direct benefits of the design. M.G.J.

N67-31998# Hewlett-Packard Co., Palo Alto, Calif.
A CURRENT PREAMPLIFIER FOR MAGNETIC TAPE PLAYBACK SYSTEMS
Arndt B. Bergh *In its* Hewlett-Packard J., Vol. 18, No. 4 Dec. 1966 p 8–9 (See N67-31996 17-09)

Comparative data are presented on the voltage equivalent circuit and the current equivalent circuit of a tape recorder head. Frequency characteristics for each model are graphed and it is shown that, although the current model does not have the rising

characteristics of the voltage model, it is flat for lower frequencies. It is pointed out that the use of a low-input impedance current amplifier eliminates the effects of input capacity on the signal current; minimizes, if not removes, the effects of eddy current losses; and allows greater freedom in the design of the input circuit for optimizing the signal-to-noise ratio. M.G.J.

N67-31999# Hewlett-Packard Co., Palo Alto, Calif.
WIDEBAND CAVITY-TYPE COAXIAL FREQUENCY METERS
Stephen F. Adam and Anthony S. Badgar *In its* Hewlett-Packard J., Vol. 18, No. 4 Dec. 1966 p 10–12 *ref* (See N67-31996 17-09)

Specifications and design details are provided on two cavity wavemeters developed for measuring frequencies in coaxial systems. The wavemeters are described as simply calibrated tunable cavities coupled to coaxial transmission lines. The cavities used are quarter-wavelength coaxial transmission lines, shorted at their upper ends and open at their lower ends. To measure the frequency of a signal on the transmission line, the wavemeter is tuned until the transmitted power dips, indicating that the resonant frequency of the cavity is the same as the transmitted frequency and that the cavity is absorbing power from the transmission line. The unknown frequency is then read from a calibrated dial on the wavementer. The models are considered to be inexpensive, reliable, and free from spurious responses over their frequency ranges, which are 0.96 to 4.2 GHz and 3.7 to 12.4 GHz, respectively. High-resolution spiral scales have tracking errors less than ±0.1%. M.G.J.

N67-32000# Hewlett-Packard Co., Palo Alto, Calif.
SIMPLIFIED TECHNIQUE FOR EVALUATING DIODE RF PERFORMANCE
Bernard Levine *In its* Hewlett-Packard J., Vol. 18, No. 4 Dec. 1966 p 12–13 (See N67-31996 17-09)

A simplified test technique for evaluating the optimizing performance of a step recovery diode in a single stage frequency multiplier is described. The bias is applied from a 1 kHz negative going sawtooth voltage generator of low output impedance; this saw tooth bias is simultaneously applied to sweep an oscilloscope while the output power is being observed. In the test set-up depicted, a hot carrier diode is connected across the output of the amplifier to clip the positive portion of the sawtooth. It is pointed out that this technique of displaying output power vs bias enables rapid evaluation of a step recovery diode in a harmonic generator for maximum power output. In addition, spectrum breakup and abrupt changes of power output vs bias can be observed. M.G.J.

N67-32001# Hewlett-Packard Co., Palo Alto, Calif.
SWEPT-FREQUENCY SWR MEASUREMENTS IN COAXIAL SYSTEMS
Stephen F. Adam *In its* Hewlett-Packard J., Vol. 18, No. 4 Dec. 1966 p 14–20 refs (See N67-31996 17-09)

Details are given on a slotted line method for swept-frequency standing wave ratio (SWR) measurements. The required equipment consists of the slotted line, slotted line sweep adapter, oscilloscope, and swept frequency indicator. The slotted line is placed between the slotted-line sweep adapter and the device whose SWR is being measured. The output of the detector probe of the slotted line goes to the vertical input of the oscilloscope; the horizontal input is taken from the sweep output of the sweep oscillator. Operations and theory are explained in relation to oscillograms showing SWR measurements of a load. Sources of error are identified, and a sliding load for two-port devices is discussed. It is concluded that the technique permits quick and accurate measurements of SWR in coaxial systems up to 18 GHz. M.G.J.

N67-32026*# Boeing Co., Seattle, Wash.
SPACE RADIATION EQUIVALENCE FOR EFFECTS ON TRANSISTORS Final Report, 15 May 1965–15 Nov. 1966
R. R. Brown and W. E. Horne 4 Aug. 1967 322 p refs
(Contract NAS5-9578)
(NASA-CR-814; D2-84068-2) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Irradiation tests of 10 types of n-p-n and p-n-p silicon transistors at proton energies of 1, 20, and 100 MeV and a Co^{60} gamma ray exposure test are described. The results of these tests and the previously described electron tests are described not only in terms of their effects on transistor parameters, but also in terms of radiation equivalences for permanent displacement damage. Displacement effects were observed to dominate proton damage; however, low level exposures of electrons (typical of space mission) cause nonlinear damage which is not attributable to either displacement of temporary surface channeling effects. The energy dependences for both proton and electron displacement damage, as well as damage constants, have been obtained for the 10 transistor types tested. Nonlinear damage was identified and preliminary characterization was made. The feasibility of using Co^{60} gamma-ray sources to simulate radiation effects of electrons and protons was also assessed in terms of linear and nonlinear damage. Author

N67-32102# Eidgenossische Technische Hochschule, Zürich (Switzerland).
HIGH FREQUENCY DC REGULATOR BY MEANS OF THE SEQUENTIAL TIMING PROCESS [HOCHFREQUENTER GLEICHSPANNUNGSREGLER MITTELS DES ZEITSTAFFELUNGSVERFAHRENS]
Ivan Horvat (Ph.D. Thesis) 1966 102 p refs In GERMAN
(DISS-3847) CFSTI: HC $3.00/MF $0.65

A switching mode current stabilizer circuit is described that uses silicon rectifier control in a sequential timing process for high frequency direct current regulation. This sequential timing process eliminates idling time for the thyristors by scheduling the ignition impulse range of several independent circuits in proper consecutive method. Transl. by G.G.

N67-32124# General Electric Co., Owensboro, Ky. Tube Dept.
C-BAND AND X-BAND DUAL-FUNCTION OSCILLATORS Quarterly Report, 1 Dec. 1966–28 Feb. 1967
J. D. Marshall and J. B. Quirk Jun. 1967 17 p
(Contract DA-28-043-AMC-02340(E))
(ECOM-02340-3; RCS-OSD-1366; QR-3; AD-653155) CFSTI: HC $3.00/MF $0.65

Tube design efforts continued in the areas of grid structures and the bonded heater-cathode structure. The first grid structure to provide a spectrum with no appreciable FM content was used with the radiation-type heater-cathode structure. Tubes were fabricated incorporating this grid structure, plus minor variations, with the bonded heater-cathode structure. Because of excess power in the local oscillator function, and mechanical problems, oscillator DC-4 was discontinued in favor of oscillator No. EL-PO (X-1), to which the following modifications were made: installation of an effective rf choke in the grid circuit; addition of a 1/8 in. tuning shaft; redesign of the feedback circuit; increased length of the oscillator body; and redesign of the heater connections. Author (TAB)

N67-32129# Boeing Co., Seattle, Wash. Geoastrophysics Lab.
A NEW TECHNIQUE FOR MEASURING POWER SPECTRA OF COMPLEX NON STATIONARY SIGNALS
J. F. Kenney, T. K. Deaton, and J. E. Miller Dec. 1966 16 p ref
(D1-82-0585; AD-652427)

In scientific research it is frequently desirable to make an accurate measurement of the power spectrum of a complicated time-varying signal. The performance of a Sona-Graph Audio Spectrum Analyzer can be upgraded for this purpose by changing

the output format from a carbon-deposited paper that is burned by an electric arc to an oscilloscope and camera system. The time resolution is improved, and direct amplitude measurements are now possible. The utility of the system is demonstrated by analysis of samples of VLF and ULF emissions. The technique can be used in many fields of scientific research, such as geophysics, oceanography, biology, medicine, and acoustics. Author (TAB)

N67-32133# New York Univ., N. Y. Lab. for Electroscience Research.
MULTIPARAMETER SENSITIVITY IN ACTIVE RC INTEGRATED CIRCUITS
Robert W. Tarmy and Mohammed S. Ghausi Nov. 1966 72 p refs
(Contract AF 19(628)-5537)
(TR-400-148; SR-4; AFCRL-67-0067; AD-651916) CFSTI: HC $3.00/MF $0.65

The report proposes a new definition for the multiparameter sensitivity function in linear systems. The sensitivity of various active RC synthesis design procedures which use Negative-Impedance Converters as the active elements are compared. The predictions based on the multiparameter sensitivity function are verified by calculations of the variation in the network response when the network elements vary in a given manner. Author (TAB)

N67-32161# Hewlett-Packard Co., Palo Alto, Calif.
HEWLETT-PACKARD JOURNAL. VOLUME 18, NO. 5
Jan. 1967 22 p refs

CONTENTS:

1. METHODS OF MEASURING IMPEDANCE C. G. Gorss p 2–11 refs (See N67-32162 18-09)

2. DIRECT-READING, FULLY-AUTOMATIC VECTOR IMPEDANCE METERS G. J. Alonzo, R. H. Blackwell, and H. V. Marantz p 12–20 refs (See N67-32163 18-09)

N67-32162# Hewlett-Packard Co., Palo Alto, Calif.
METHODS OF MEASURING IMPEDANCE
Charles G. Gorss *In its* Hewlett-Packard J., vol. 18, no. 5 Jan. 1967 p 2–11 refs (See N67-32161 18-09)

A review is presented of some improtant systems for measuring the impedance of devices and circuits. Basic concepts of electronic circuit elements are discussed, along with the difficulties in making theoretical calculations for predicting circuit performance. Major topics covered include resistance measurements, impedance bridges, bridge systems, semiautomatic bridges, Q meters, direct reading impedance meters, and impedance measurements at high frequencies. C.T.C.

N67-32163# Hewlett-Packard Co., Palo Alto, Calif.
DIRECT-READING, FULLY-AUTOMATIC VECTOR IMPEDANCE METERS
Gerald J. Alonzo, Richard H. Blackwell, and Hirsh V. Marantz *In its* Hewlett-Packard J., vol. 18, no. 5 Jan. 1967 p 12–20 refs (See N67-32161 18-09)

Two instruments for measuring impedance magnitudes and phase angles over a broad frequency range are described. Specifications are given for the devices, as well as circuit schematics and the various operation modes. The design philosophy is discussed, and specific areas of application are described. C.T.C.

N67-32262# Philco Corp., Lansdale, Pa. Microelectronics Div.
LOW COST INTEGRATED CIRCUIT TECHNIQUES Final Report, 15 Jun. 1966–14 Sep. 1966
Sturger Wagner and Walter L. Doelp, Jr. May 1967 100 p ref
(Contract DA-28-043-AMC-01424(E))
(ECOM-01424-F; Rept.-5; AD-652699) CFSTI: HC $3.00/MF $0.65

An over-all process was developed for glass coating of silicon integrated circuit chips and batch attaching them to an appropriately processed substrate. The techniques developed were demonstrated by delivery of four 10-chip arrays consisting of glassed silicon micro-circuits flip-chip assembled on a plug-in printed circuit board. Detailed information is provided concerning wafer glassing and other processing leading to flip-chip assembly. In addition to the delivery of the final exploratory development models, other development units were fabricated and subjected to a test sequence intended to demonstrate the effectiveness of the developed process. Although the assignment of a quantitative failure rate was considered unrealistic because of the limited sample size, the analysis of the test data led to the conclusion that no catastrophic or major deleterious effects result from the combined glass and batch assembly process. Author (TAB)

N67-32263# Michigan Univ., Ann Arbor. Cooley Electronics Lab.
THE PHASE SYNCHRONIZATION OF A PARAMETRIC SUBHARMONIC OSCILLATOR
James L. Cockrell Apr. 1967 213 p refs
(Contracts DA-28-043-AMC-01870(E); DA-36-039-AMC-00059(E); DA-28-043-AMC-00029(E))
(ECOM-01870(E)-8-T; CEL-TR-7695-178; AD-653032) CFSTI: HC $3.00/MF $0.65

The general problem of phase determination for a parametric subharmonic oscillator is formulated. The analyses of several circuits are reduced to the solution of the canonical Mathieu equation. Solution is effected by the Floquet theorem and the parameters discussed in terms of the range of values encountered in experimental circuits. The transient portion of the solution produces arbitrary constants with two possible signs, yielding the two phase states of a growing oscillation. Conditions of oscillation are discussed, and the influence of signal and noise presented. TAB

N67-32269# Bendix Corp., Teterboro, N. J. Navigation-Control Div.
[MICROELECTRONICS FOR THE AIR-BEARING SERVO LOOP ELECTRONICS] Phase Completion Report
B. F. Osterlok 31 Mar. 1967 354 p refs
(Contract NAS8-11916)
(NASA-CR-86632) CFSTI: HC $3.00 CSCL 09C

A research program was conducted to obtain higher reliability, longer operating life, and savings in space and weight with regard to air-bearing (gyro and accelerometer) servo loop electronics. A summary of program accomplishments from initial design to fabrication of six prototype amplifiers is presented. A description, complete with illustrations, of a prototype microelectronic servo amplifier is given. Module and amplifier operational characteristics are described by typical evaluation test data, and a brief summary of the environmental test program is included. C.T.C.

N67-32340# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y. Dept. of Electrophysics.
WIDE-ANGLE INTERNAL DEFLECTION STRUCTURES OF CATHODE-RAY TUBES Triannual Report, 1 Jul.–31 Oct. 1966
Rudolf G. E. Hutter Apr. 1967 15 p refs
(Contract DA-28-043-AMC-02449(E))
(PIBMRI-1355.1-66; ECOM-02449-1; Rept.-1; AD-652718) CFSTI: HC $3.00/MF $0.65

Theoretical studies were made to derive suitable forms of the focal length of a deflection system and with the effect of isolation electrodes between the horizontal and vertical deflection systems. Discussion led to the design of an electron gun, suitable for studies of dynamic correction of deflection defocussing by means of electrodes in the main lens which have elliptical apertures. This gun will be ready for tests early in December 1966. Studies continue to determine theoretically the functional relation between deflection voltage and dynamic correction voltage. Author (TAB)

N67-32480# Radio Corp. of America, Somerville, N. J.
THIN-FILM POLYCRYSTALLINE FIELD-EFFECT TRIODE Quarterly Report, 1 Jan.–31 Mar. 1966
M. L. Topfer, A. H. Dania, and A. K. Rapp May 1967 17 p
(Contract DA-28-043-AMC-02432(E))
(Rept.-3; ECOM-02432-3; AD-652885) CFSTI: HC $3.00/MF $0.65

The report contains work on the complementary three-input NAND gate circuit. Twelve additional circuits were delivered to Fort Monmouth for evaluation. A new set of masks was designed for this circuit which will lead to improved performance and frequency response. Life test data that have been accumulated for almost three thousand hours are presented. Test data on the delivered circuit are also presented. Author (TAB)

N67-32504# Stanford Univ., Calif. Stanford Electronics Labs.
SOLID-STATE ELECTRONICS
In its Quart. Status Rept., 1 Oct.–31 Dec. 1966 31 Dec. 1966 p 11–32 refs (See N67-32501 18-10)

Continuing research is reported in the following areas: (1) microprobe requirements and developments for medical electronics; (2) fabrication of GaAs Schottky barrier –I–N^+ photodetectors with varying I-layer thicknesses to determine drift velocities of electrons; (3) growth of GaP single crystals and determination of partial vapor pressures; (4) measurements of optical properties of phthalocyanine organic semiconductors; (5) investigating piezomagnetic constants and other phenomena of αFe_2O_3 and CoF_2; and (6) fabrication of n- and p-channel MOS transistors and plotting their voltage–current characteristics. Progress in two new projects are also reported: (1) construction and testing of high performance electron beam switched p–n junction amplifier, and (2) developing circuit techniques for obtaining a linear response from integrable photosensitive semiconductor devices. N.E.N.

N67-32533# General Electric Co., Gainesville, Fla. Tube Dept.
C-BAND AND X-BAND DUAL FUNCTION OSCILLATORS Quarterly Report, 1 Sep.–30 Nov. 1966
J. D. Marshall and J. B. Quirk Jun. 1967 15 p
(Contract DA-28-043-AMC-02340(E))
(QR-2; ECOM-02340-2; AD-653154) CFSTI: HC $3.00/MF $0.65

Effort is continuing toward the design of a grid structure that will reduce to an acceptable level the FM component of the RF output attributable to grid wire motion. Several lots of tubes were made with widely dispersed characteristics in order to determine the optimum design for operation as a dual function oscillator. Two slot-coupled CW reference oscillators were made and found to be satisfactory. It was found that an oscillator cavity, optimized for the 7910 tube type, was not optimum for the Y-1662 tube type. It will, therefore, be necessary to postpone finalization of the internal structure of the oscillator until the final tube design has been made. A change of 88 MHz in the frequencies difference between the frequency of the transmit function and that of the local oscillator function was realized by an alteration of the internal impedance ratio of the oscillator. Author (TAB)

N67-32537# Utah Univ., Salt Lake City. Microwave Device and Physical Electronics Lab.
ELECTRON BEAM STABILITY IN CYCLOTRON-SYNCHRONOUS WAVE AMPLIFIERS
M. T. Ahlquist, C. C. Johnson, and K. I. Talbot Dec. 1966 37 p refs
(Contract DA-36-AMC-02372(E))
(EC-2; MD-66-024; AD-653010) CFSTI: HC $3.00/MF $0.65

Experiments with the cyclotron-synchronous wave microwave amplifier (see AD-652 009) have encountered difficulties, in some cases, due to beam blow-up in the low pump voltage-low space charge regime. A computer-assisted theoretical investigation of the problem was undertaken and the results are reported. TAB

N67-32544# Army Electronics Labs., Fort Monmouth, N. J.
EXTENDED LIFE TEST OF SOLID ELECTROLYTE TANTALUM CAPACITORS
Herschel L. Stout Mar. 1967 15 p refs
(ECOM-2812; AD-652891) CFSTI: HC $3.00/MF $0.65

Capacitance, dissipation factor and dc leakage of solid electrolyte tantalum capacitors were measured at intervals throughout a 26,000-hour life test. Seventy-five percent of ten capacitors survived with no degradation in properties and no indication of impending wearout. All failures were associated with a measurement period, leading to the inference that discharging and recharging operations may be a failure hazard. Author (TAB)

N67-32621 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SEMICONDUCTOR INSTRUMENTS AND THEIR APPLICATION—SELECTED ARTICLES
6 Dec. 1966 53 p refs Transl. into ENGLISH from Poluprov. Pribory i Ikh Primeneniye. Sbornik Statey. (Moscow), no. 11, 1964 p 59–110
(FTD-MT-65-477; AD-648888)

CONTENTS:

1. ANALYSIS OF FREQUENCY MULTIPLIER BUILT AROUND NONLINEAR CAPACITANCE V. M. Val'd-Perlov p 1–10 refs (See N67-32622 18-09)

2. TWO-CIRCUIT FREQUENCY MULTIPLIERS BUILT AROUND NONLINEAR CAPACITANCE B. N. Krasnogolovyy p 11–45 refs (See N67-32623 18-09)

N67-32622 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ANALYSIS OF FREQUENCY MULTIPLIER BUILT AROUND NONLINEAR CAPACITANCE
V. M. Val'd-Perlov *In its* Semicond. Instr. and Their Appl., 6 Dec. 1966 p 1–10 refs (See N67-32621 18-09)

The operation of two-circuit frequency multiplier using nonlinear capacitance of diode in two circuits, series and parallel types is considered. Comparison is made of these circuits, taking into account parameters of body of diode. It is shown that it is impossible to generate higher harmonics in two-circuit multiplier of parallel type using diodes with sharp transition. Operation of frequency doubler is considered in detail. Author

N67-32623 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TWO-CIRCUIT FREQUENCY MULTIPLIERS BUILT AROUND NONLINEAR CAPACITANCE
B. N. Krasnogolovyy *In its* Semiconduct. Instr. and Their Appl., 6 Dec. 1966 p 11–45 refs (See N67-32621 18-09)

The analysis of model two-circuit frequency multipliers using nonlinear capacitance of p–n junction of semiconductor diodes is presented. Simple design relationships for selection of optimum parameters of multipliers and basic characteristics of multiplier diodes are obtained. A comparative appraisal of model circuits of multipliers is given, and recommendations for their application are made. Author

N67-32655# General Electric Co., Irmo, S. C. Electronic Specialty Capacitor Business Section.
PRODUCTION ENGINEERING MEASURE FOR IMPROVED RELIABILITY OF HERMETICALLY SEALED TANTALUM FOIL CAPACITORS Quarterly Report, 20 Dec. 1966–20 Mar. 1967
R. M. Trewhella Mar. 1967 17 p
(Contract DA-36-039-AMC-00169(E))
(QR-6; AD-652283) CFSTI: HC $3.00/MF $0.65

The successful performance of the 9150 capacitors in the reliability proof test for 2000 hours at rated voltage and 125C

represents 18.3 million unit hours without a failure and a failure rate of 0.005% per thousand hours at 60% confidence. Author (TAB)

N67-32659# General Motors Corp., Kokomo, Ind. Delco Radio Div.
STUDY OF GERMANIUM DEVICES FOR USE IN A THERMOPHOTOVOLTAIC CONVERTER Progress Report, 19 Jul. 1966–1 Jan. 1967
R. W. Beck Feb. 1967 59 p
(Contract DA-28-043-AMC-02543(E))
(ECOM-02543-1; PR-1; Rept.-1; AD-652103) CFSTI: HC $3.00/MF $0.65

An investigation was made of the front junction P(+)/N absorptive device structure since it was felt that this device might be inherently more stable and exhibit higher values of collection efficiency. Values of collection efficiency approaching 100% were obtained but the stability in vacuum is not improved over the N/P(+) configuration. Power output of the P(+)/N is limited by the curve factor at P(+) dopings of 10 to the 18th power/cu cm. Increased doping of the P(+) region seriously degrades device collection efficiency. The complete reversibility of the vacuum degradation and its dependence on I sub sc levels were determined. Vacuum coating work has been extended to include silicon dioxide, silicon carbide, cadmium sulfide and others in the electron beam evaporator. None of these contributes to device stability. Increased stability of ZnS coated devices was demonstrated. Attempts to fabricate N/P(+) devices by epitaxial deposition were unsuccessful because of doping problems. Sufficient P-type layers were not obtained resulting in poor diode structures. The decision to discontinue the epitaxial work was made. Continued development of polishing techniques yielded N/P(+) nonabsorptive devices with negligible scattering losses before electroetching. Author (TAB)

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-31711# Los Alamos Scientific Lab., N. Mex.
CROWBAR CODE
D. A. Baker and L. W. Mann 12 Apr. 1967 61 p Supersedes LAMS-2435
(Contract W-7405-ENG-36)
(LA-3548; LAMS-2435) CFSTI: HC $3.00/MF $0.65

The Crowbar code is designed for the transient analysis of the linear electrical circuits often used in controlled fusion experiments to produce strong sustained magnetic fields by means of charged capacitor energy sources. The computer code calculates the natural periods and decay times and the following as functions of time: currents, voltages, instantaneous energy storage, and energy dissipation rates for each of the appropriate circuit elements. The calculations are made with explicit formulas; no numerical integrations are required. The program is written in FORTRAN IV and is currently being used on a 32K IBM 7094. The output results are presented as printed listings on 35-mm film. Author (NSA)

N67-31802*# Ohio State Univ., Columbus. Electro Science Lab.
APERTURE REFLECTION COEFFICIENT OF A PARALLEL-PLATE WAVEGUIDE BY WEDGE DIFFRACTION ANALYSIS
R. C. Rudduck and L. L. Tsai Washington, NASA, Jul. 1967 45 p refs
(Grant NsG-448)
(NASA-CR-818; TR-1691-20) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Wedge diffraction theory is applied to analyze the aperture reflection coefficients of TEM and TE_{01} parallel-plate waveguide apertures. Fields of the guides are used in conjunction with the guide effective apertures to obtain the reflection coefficients and hence aperture admittances. Calculated results of reflection coefficients versus guide widths are verified by measurements and results from other methods of analysis. Author

N67-32096*# Emerson Electric Co., St. Louis, Mo.
CONTINUATION OF THEORETICAL AND EXPERIMENTAL RESEARCH ON DIGITAL ADAPTIVE CONTROL SYSTEM, 16 SEPTEMBER 1966–16 FEBRUARY 1967
John Zaborszky, R. G. Marsh, R. E. Janitch, and M. R. Chidambara Jul. 1967 181 p refs
(Contract NAS1-6669)
(NASA-CR-810; Rept.-2126) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A new digital adaptive control system is further developed for a priori unknown plants. Two alternate methods for representing unknown linear non-stationary plants based on linear interpolation are investigated. More than 600 control efficacy simulations of a representative plant spectrum through fifth order are analyzed. A new recursive procedure for the inversion of a type of matrix encountered in the calculation of the interpolation representation of unknown plants is developed. A first order Volterra series representation of unknown linear stationary and linear nonstationary plants is developed and reduced to working equational form. Non-linear plant representations by linear interpolation and by interpolation over quadratic forms are developed. Control efficacy simulations utilizing the linear and non-linear interpolation are made and the two representations are compared. Control using either representation is demonstrated. A data truncation study is made in which significant figures available in the plant output state data are limited. Control simulations are made using truncated data to periodically update the interpolation representation of unknown linear stationary plants. Author

N67-32189# Stanford Univ., Calif. Microwave Lab.
MICROWAVE RESEARCH Quarterly Status Report, 1 Aug.–31 Oct. 1966
Nov. 1966 19 p refs
(Contract Nonr-225(48))
(ML-1491; QSR-31; AD-645239) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. OPTICAL MASER RESEARCH A. L. Schawlow, R. M. Macfarlane, and S. Johnson 9 p refs (See N67-32190 18-16)

2. GENERATION OF A DOMAIN IN CADMIUM SULFIDE BY INJECTED ACOUSTIC NOISE W. H. Haydl 10 p refs (See N67-32191 18-26)

N67-32218*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
AUTOMATIC CONTROL
A. E. Bryson, Jr., R. E. Kronauer, Y. C. Ho, A. R. Dobell, K. J. Bullock *et al* *In its* Cruft Lab. Mar. 1967 11 p refs (See N67-32215 18-34)
(Grant NsG-559)

Analog computer studies were performed on parameter perturbation adaptive control techniques where the basic plant was third and fifth order. A class of nonlinear oscillation problems arising in the theory of dynamic buckling is being studied; and in optical storage and processing studies, the prediction of a grain

noise analysis for uniformly exposed emulsion were confirmed experimentally. Other automatic control problems reported on include: 1) numerical solutions of optimal control problems, 2) comparison of quadratic synthesis with pole-zero synthesis, 3) optimal economic growth plans, 4) numerical solution of nonlinear programming problems, 5) filtering for multi-stage systems with correlated measurement noise, 6) perturbation feedback control and optimal programming problems, and 7) optimum communication with a feedback channel. L.S.

N67-32227# Joint Publications Research Service, Washington, D. C.

THE SYNTHESIS OF LOGIC CIRCUITS TRANSFORMING INFORMATION TO A HAMMING CODE

A. D. Zakrevskiy *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 97–103 refs (See N67-32222 18-07)

Reliability problems of logic circuits are discussed. An analysis is made of a possible method which avoids the use of correcting circuits by replacing the principle of multiplication of binary variables with the method of compact interference stable coding. This approach is used to analyze the problem of synthesizing logic circuits which transform information to a Hamming code. R.N.A.

N67-32236# Joint Publications Research Service, Washington, D. C.

DIODE LOGIC ELEMENTS BASED ON PRINTED BANDS OPERATING IN shf RANGE

V. A. Beruashvili *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 242–251 refs (See N67-32222 18-07)

An analysis is made of methods for constructing logic elements and superhigh speed digital computer sections based on the use of amplitude modulation of superhigh frequency oscillations in flat printed lines. Simple and small computer logic elements can be produced by using the flat printed lines. High speed operation can be achieved by using the flat printed lines in combination with diode valve elements. However, the present microwave diodes are poorly matched in design with flat printed lines. One disadvantage of the flat printed lines is the fact that they only operate up to 6000 Mc. In the 10,000 Mc range, they introduce considerable losses and distortions. It is expected that further developments of new dielectric materials will expand their frequency range. R.N.A.

N67-32239# Joint Publications Research Service, Washington, D. C.

ELEMENTS OF COMPUTER MACHINES BASED ON TUNNEL DIODES

V. A. Beruashvili and O. A. Elizbarashvili *In its* Cybernetics in the Service of Communism, Vol. 3 Jun. 1967 p 275–284 refs (See N67-32222 18-07)

Characteristics of the tunnel diode are described along with its application to computers. Emphasis is placed on combining tunnel diodes with transistors for constructing high speed potential type circuits. The reliability, power requirements, speed of operation, and resistance to radiation and temperature changes of tunnel diodes make them extremely promising for use in discrete operation computers. R.N.A.

N67-32240# Joint Publications Research Service, Washington, D. C.

VOLTAGE-CODE FIBER OPTICS CONVERTER

M. V. Chkheidze *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 285–289 (See N67-32222 18-07)

The construction and performance of an optical converter for transforming low voltage levels to codes is described. The device is based on fiber optics techniques. R.N.A.

N67-32241# Joint Publications Research Service, Washington, D. C.

CONVERTER FOR TRANSFORMING CONTINUOUS QUANTITIES TO DISCRETE QUANTITIES

M. V. Chkheidze *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 290–301 refs (See N67-32222 18-07)

An analysis is made of problems concerned with the conversion of voltage to code using a two-step converter principle. A converter is developed which is constructed on the principle of discrete measurement of the charge time of a capacitance up to the converted voltage level. Author

N67-32325# California Univ., Berkeley. Electronics Research Lab.

A SYNTHESIS METHOD FOR CROSSED-FIELD ELECTRON GUNS

R. A. Rao Mar. 1967 180 p refs
(Contract DA-36-039-AMC-02164(E))
(ECOM-02164-14; IR-14; AD-652701) CFSTI: HC $3.00/MF $0.65

A general approximate method for the synthesis of crossed-field sheet beams and for the determination of electrodes to produce such beams is developed. The limitations of the method and its accuracy are discussed with reference to some problems of practical importance in microwave amplifiers. The problem of synthesizing an electron beam requires compromises among various competing factors; hence it is desirable to work with approximate methods in which the effects of the various requirements may be studied and modifications may be made on these requirements. The first-order paraxial-ray equation is such an equation in which the important beam parameters are included in a simple mathematical description of the central trajectory of the beam. The approximation comes about in specifying the beam parameters on the nonaxial trajectories in terms of power-series expansions of their values on the axis and neglecting higher-order terms in beam thickness. This approximation is shown to be sufficiently accurate for thin beams. The numerical solutions for the beam parameters obtained from the paraxial-ray equation may be put in analytic form by using polynomial approximations, and analytic methods may be used for the determination of the electrodes to produce such beams. Author (TAB)

N67-32401 Joint Publications Research Service, Washington, D. C.

CYBERNETICS IN THE SYSTEM OF CONTROL SCIENCES

V. Bogolepov 9 May 1967 6 p Transl. into ENGLISH from Ekon. Gaz. (Moscow), no. 15, Apr. 1967 p 19
(TT-67-31598; JPRS-40956)

The relationship of cybernetics to the classical science of control is discussed, in relation to the divergent viewpoints which exist on the subject. Three positions are examined: (1) the evaluation of cybernetics as an auxiliary discipline to the complex of logical–mathematical knowledge and computer technology, addressed only to the quantitative side of the processes of control; (2) a science of the reorganization of information; and (3) assignment to the role of the modern science of control, although with some reservations. Rebuttals to these views are presented, and a strong recommendation is made that the classical and cybernetic channels of administrative science should be united into a single system both as relates to general principles and to all of its separate interpretations. M.G.J.

N67-32479# RAND Corp., Santa Monica, Calif.

NETWORKS, FRAMES, BLOCKING SYSTEMS

D. R. Fulkerson May 1967 63 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5388-PR; AD-663178) CFSTI: HC $3.00/MF $0.65

A survey of some of the basic problems, theorems, and constructions for flow networks, and their extension to more

general combinatorial structures. One generalization is that obtained by replacing the vertex-edge incidence matrix of an oriented network by an arbitrary real matrix. This leads to the notion of a frame of a sub-space of Euclidean n-space, a concept very closely allied to that of a real matric matroid. The treatment relates matroid theory and linear programming theory, and thus provides another viewpoint on linear programming, and in particular, on digraphoid-programming. In addition, a very general combinatorial structure called a blocking system is given an axiomatic formulation. These systems have arisen in a variety of contexts, including multi-person game theory and abstract covering problems. It is shown that one of the network theorems surveyed in the study extends to all blocking systems, and indeed characterizes such systems. TAB

N67-32501# Stanford Univ., Calif. Stanford Electronics Labs.
QUARTERLY STATUS REPORT, 1 OCTOBER–31 DECEMBER 1966
31 Dec. 1966 97 p refs
(Contract Nonr-225(83))
(SEL-67-007; QSR-104; AD-649819) CFSTI: HC $3.00/MF $0.65

CONTENTS:
1. PLASMA PHYSICS AND QUANTUM ELECTRONICS p 1–5 (See N67-32502 18-25)
2. RADIOSCIENCE p 6–10 refs (See N67-32503 18-29)
3. SOLID-STATE ELECTRONICS p 11–32 refs (See N67-32504 18-09)
4. SYSTEMS TECHNIQUES p 33–35 (See N67-32505 18-14)
5. SYSTEMS THEORY p 36–59 refs (See N67-32506 18-10)

N67-32506# Stanford Univ., Calif. Stanford Electronics Labs.
SYSTEMS THEORY
In its Quart. Status Rept., 1 Oct.–31 Dec. 1966 31 Dec. 1966 p 36–59 refs (See N67-32501 18-10)

Progress is reported on the following research projects: (1) studies of Bayes sequential learning and decision theory, question–answering automata, and visual pattern recognition; (2) implementation of modeling structure for adaptive decision systems; (3) fabrication of buffer-storage unit for hybrid analog–digital computer; (4) application of conjugate gradient method to optimal control problems; (5) fabrication of an integrated gyrator and mathematical techniques for investigating the connection between network theory and general systems theory; (6) developing a method to describe the lossless matching network to be used in synthesizing wideband impedance-matching networks; (7) initial studies of binary and multilevel digital communication over sampled-data channels with memory; and (8) investigations of communication schemes using an intermittent feedback link, variable-time decision feed back scheme, and nonlinear filtering and detection theories. N.E.N.

N67-32545# Goodyear Aerospace Corp., Akron, Ohio.
DISTRIBUTED ADAPTATION IN NEUROMIME NETWORKS Interim Report, Jun. 1964–Jun. 1966
V. V. Griffith and G. H. Bolen Wright-Patterson AFB, Ohio. AMRL Jan. 1967 95 p refs
(Contract AF 33(615)-1891)
(GER-12738; AMRL-TR-66-225; AD-652853) CFSTI: HC $3.00/MF $0.65

The report describes investigations of networks with adaptive ability distributed through them. It is thought that large-scale systems can be constructed of adaptive building blocks. These adaptive systems would be flexible in function, reliable and would resist severe damage characteristics of living creatures. Neuron models were tested by interconnecting them into various networks to perform simple control tasks. The test results were evaluated and the evaluation used to improve the theory and the neuron model. Two basic analysis methods were used to study neuromime networks: a sequential machine analysis and an optimal process method applying Pontryagin's maximum principle. The sequential analysis method proved unsatisfactory when applied to an attempted description of an adjustment rule for the neuron model. This difficulty led to an application of optimal processes. The application of Pontryagins maximum principle to the analysis of the neuron model network described both optimum conditions for a system and criteria useful for developing the adjustment rule. Author (TAB)

N67-32668# Hughes Research Labs., Malibu, Calif.
MAGNETIC COMPRESSION OF ELECTRON BEAMS Quarterly Report 1 Oct.–31 Dec. 1966
Kurt Amboss May 1967 40 p refs
(Contract DA-28-043-AMC-01463(E))
(ECOM-01463-6; AD-652278) CFSTI: HC $3.00/MF $0.65

The objective of the program is to compress a 0.00000054 AV to the 3/2 power electron beam by a factor of 1000, primarily by the use of magnetic fields, and to gain an understanding of the behavior of dense thermal electron beams. Magnetic compression has been demonstrated in a demountable vacuum system. Stable nonrippling beams compressed by factors of 200, 600, and the required 1000 have been produced at a 3 kV beam voltage. In each case the magnetic field acted to compress the beam over a relatively short region; the distance from the cathode to the point where the magnetic field became uniform was only twice as great as that required to introduce the same beam into a uniform field without magnetic compression. The structure of the beam was found to disappear with distance. TAB

N67-32695# Illinois Univ., Urbana. Coordinated Science Lab.
NECESSARY CONDITIONS FOR TRANSFORMERLESS REALIZATION OF ONE-TERMINAL PAIR RLC WITH ONE RESISTOR
Abelardo Casas Sabino (M.S. Thesis) May 1967 43 p refs
(Contract DA-28-043-AMC-00073(E))
(R-351; AD-653157) CFSTI: HC $3.00/MF $0.65

The dependence of the coefficients of the driving point functions of RLC networks on the resistors are derived. Their specialization to the case of one resistor RLC networks are then shown to lead to necessary conditions for the possibility of transformerless realization with one-resistor. Author (TAB)

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-31514# Polytechnic Inst. of Brooklyn, Farmingdale, N. Y.
A REVIEW OF WORK PERFORMED AT THE POLYTECHNIC INSTITUTE OF BROOKLYN AEROSPACE LABORATORIES UNDER CONTRACT AF 33(657)-8286 Final Report
Robert J. Cresci Wright-Patterson AFB, Ohio, ARL, Aug. 1966 107 p refs
(Contract AF 33(657)-8286)
(PIBAL-991; ARL-66-0161; AD-652227) CFSTI: HC $3.00/MF $0.65

The research program reviewed in this report deals with the development of a high pressure, high temperature, wind tunnel facility. The basic air supply system is referred to as the 'Mechanical

Accelerator and consists of either a single, or series, of supersonic compressor rotors; these rotors accelerate the flow at essentially constant conditions and in this manner produce a high velocity stream of gas which is capable of being used in an aerodynamic test facility. Several associated problem areas such as the boundary layer behavior in curved passages, cascade tests, surface cooling, nozzle design, and ejector performance were also investigated. The overall program led to the design development of a single stage accelerator for which the detail manufacturing and assembly drawings are available. The single stage machine resulting from this study can be used as a pilot model and will not provide the very high enthalpy, high pressure flow capability of the ultimate multistage machine. Author (TAB)

N67-31803# Union Carbide Nuclear Co., Paducah, Ky.
DESIGN AND FABRICATION OF A PROTOTYPE LAMINATED URANIUM METAL SHIPPING CASK FOR LARGE SHIPMENTS OF COBALT-60
C. B. Clifford 3 Apr. 1967 38 p
(Contract W-7405-ENG-26)
(KY-521) CFSTI: HC $3.00/MF $0.65

The design standards, engineering drawings and the manufacturing techniques used in fabricating a prototype laminated depleted uranium metal shipping cask for transporting 150,000-curie lots of cobalt-60 are presented. The cask design was based on criteria furnished by the Oak Ridge National Laboratory and the latest drafts of the proposed 10 CFR 71 regulations and Chapter AEC-0529. Emphasis was placed on reducing the weight and volume of the cask in order to minimize the problems associated with transporting and handling the cask in the cells located at ORNL and their customer's facilities. Heat transfer test data are presented to show the temperatures obtained by dissipating up to 1.8 times the design heat load of electrical energy inside the cask. Author (NSA)

N67-31849*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
UNDERWATER OPERATION EXPERIMENTS EVALUATION
John R. Rasquin 29 May 1967 17 p
(NASA-TM-X-53614) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The results of three evaluation studies of operations in a zero "G" engineering mock-up facility are combined. The requirements to modify a standard impact wrench for underwater operations are presented. A regulator valve used in the exhaust port of a high altitude suit to maintain working pressure under a hydraulic head is described. The results of an evaluation of three types of hatches used to provide ingress and egress to the S-IVB workshop are given. Author

N67-31857*# Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Research and Engineering Center.
PRELIMINARY DESIGN STUDY OF A LUNAR GRAVITY SIMULATOR Interim Report
25 Oct. 1966 48 p Revision A
(Contract NAS8-20351)
(NASA-CR-84861; LMSC/HREC-A783335, Rev. A; IR-3) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A preliminary design study was conducted on a Lunar Gravity Simulator (LGS) System, a system which is to evaluate full-scale Lunar Surface Vehicles (LSV) over a simulated lunar terrain in an earth gravity environment. Results of tasks performed suggest: (1) The 3-D configuration is recommended for further design and development efforts. (2) An analog resolver network using optical type displacement sensing is recommended for controlling the 3-D drive system. (3) A driver suspension concept based on supporting 5/6 of the weight of the astronaut's arms is recommended. R.Li.

N67-31873*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
STATION AUTOMATION
Merrick E. Shawe Apr. 1966 8 p
(NASA-TM-X-55848; X-521-66-168) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Automation of satellite tracking stations is discussed in light of advantages and problem areas, and possible automated operations are listed. Reliability is considered as an advantage with respect to improved testing techniques, components, maintenance procedures, and elimination of some duplicate equipments. Reliability is also examined as a disadvantage because of the complex automated equipment. Program problems are cited as network mergers such as Apollo/STADAN, man/machine interface studies, budget cutbacks, data compression, use of communications satellites, and mission changes. S.P.

N67-31889# Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Porz (West Germany).
DIGITAL DATA RETRIEVAL FACILITY FOR A BLOWDOWN SUPERSONIC WIND TUNNEL [DIGITALE DATENERFASSUNGSANLAGE FUER EINEN BLOW-DOWN-UEBERSCHALLKANAL]
A. Heyser and H. Ziobinski *In* WGLR Rept. on the Session of the WGLR Subcomm. on Aerodyn. May 1966 p 147–162 refs (See N67-31881 18-08)

Construction and performance of a digital data acquisition system for use with supersonic wind tunnels is described. The system includes 11 measuring channels and is able to pick up about 200 measurements per second. Collected are power, static pressure, static temperature, normal pressure, ground pressure, and angle of attack measurements during tests. Data are then transferred onto punch tape for automatic readout. Transl. by G.G.

N67-31895# Joint Publications Research Service, Washington, D. C.
THE KINETICS OF REDUCING POTASSIUM BY THE VACUUM THERMIC METHOD IN LABORATORY AND PILOT-PLANT FURNACES
A. S. Mikulinskiy and I. Ye. Sipeyko *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 1–8 refs (See N67-31894 18-06)

The kinetics of vacuum thermic reduction were investigated, and methods of intensifying the process with the aid of inside heaters and corresponding vacuum and temperature regimes are reported. The steps in the reduction of potassium by carbide-chloride are described, and the temperature and vacuum regimes are outlined. It was considered that the vacuum regime is the most effective factor in the control of reduction and evaporation. It was concluded that the reduction at reaction temperatures occurs at sufficiently high rates to obtain acceptable yields within one to two hours in the laboratory furnace. The heat transfer to the reacting mixture was determined to be the limiting factor in the larger pilot-plant furnace. N.E.N.

N67-31921# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.
[SOIL-VEHICLE MECHANICS]
Nov. 1966 335 p refs
(TR-9560; RR-6; AD-651726)

CONTENTS:

1. RECENT INVESTIGATIONS OF VERTICAL LOAD-DEFORMATION CHARACTERISTICS OF SOILS E. Hegedus and R. A. Liston p 2–20 refs (See N67-31922 18-13)

2. HORIZONTAL SHEAR IN SOIL VEHICLE MECHANICS B. M. D. Wills p 21–45 refs (See N67-31923 18-13)

3. VEHICLE RIDE CHARACTERISTICS B. Hansmoto p 46–120 refs (See N67-31924 18-11)

4. STATE-OF-THE-ART OF THE ANALYSIS OF SOFT SOIL PERFORMANCE OF WHEELS Z. J. Janosi p 121–151 refs (See N67-31925 18-13)

5. STATE-OF-THE-ART OF VEHICLE PERFORMANCE PREDICTION T. F. Czako and Z. J. Janosi p 152–166 refs (See N67-31926 18-11)

6. DIMENSIONAL ANALYSIS IN LAND LOCOMOTION PROBLEMS R. A. Liston p 167–208 refs (See N67-31927)

7. SOIL STRENGTH PREDICTION BY USE OF SOIL ANALOGS W. L. Harrison, Jr. and B.-S. Chang p 209–241 refs (See N67-31928 18-13)

8. PORTABLE SOIL TEST DEVICES P. Sparski p 242–253 refs (See N67-31929 18-14)

9. WHEELED BEVAMETER FIELD TESTS D. Sloss p 254–271 refs (See N67-31930 18-11)

10. TERRAIN GEOMETRY MEASURING EQUIPMENT L. A. Martin p 272–278 (See N67-31931 18-14)

11. UNUSUAL VEHICLE AND COMPONENT CONCEPT R. A. Liston p 279–319 refs (See N67-31932 18-11)

N67-31924# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

VEHICLE RIDE CHARACTERISTICS

B. Hanamoto *In its* Soil-Vehicle Mech. Nov. 1966 p 46–120 refs (See N67-31921 18-11)

This study aimed to develop a method for designing vehicle suspension systems whereby off-road vehicle speeds over hard terrain could be increased. The study was conducted in three phases: description of the hard-ground profile as input to a suspension system; description of vehicle response using the hard-ground profile as input; and the description of the human occupants or harmful effects on vehicle components and cargo. The power spectral density description was used as the statistical method for quantitative characterization of stable hard-ground roughness, and the effect of terrain roughness on vehicle vibration was treated as a problem of a random function used as input to a linear or nearly linear system affecting the output of the system. A two-dimensional spectral computer program was written for evaluating terrain profile data. The behavior of idealized vehicles traveling over hard rough terrain was analyzed in connection with field measurements of the vehicle motion and the terrain over which it traveled. Finally, the subjective evaluation by individuals experiencing the vibratory conditions is defined, evaluation criteria are established, and experiments with 13 subjects in a ride dynamics simulator during up to 39 vibration conditions are described. K.W.

N67-31926# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

STATE OF THE ART OF VEHICLE PERFORMANCE PREDICTION

T. F. Czako and Z. J. Janosi *In its* Soil-Vehicle Mech. Nov. 1966 p 152–166 refs (See N67-31921 18-11)

Presented is a brief but complete description of the analytical system for predicting off-the-road performance of new vehicle concepts or to analyze the effect of changes in the design of vehicles. Several simplifying assumptions were made to keep the mathematics on a workable level, among them: (1) the vehicle moves in a straight line on flat terrain at a slow uniform speed; (2) the slip of all wheels or tracks is the same; (3) torques of engine, drive sprocket, or wheels are always sufficiently large to overcome limitations of soil; and (4) the weight distribution on the ground contact elements remains unchanged despite the presence of a moment created by the drawbar-pull. Methods for calculating the drawbar-pull are given for tracked and wheeled vehicles. Graphically presented and interpreted are the results of calculations of drawbar-pull/weight ratio for two wheeled vehicles, the determination of bellying value from calculated sinkages for a wheeled vehicle, and drawbar-pull and tractive efficiency of a tracked vehicle. K.W.

N67-31930# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

WHEELED BEVAMETER FIELD TESTS

David Sloss *In its* Soil-Vehicle Mech. Nov. 1966 p 254–271 ref (See N67-31921 18-11)

Construction and operation of the wheeled Bevameter are briefly summarized, followed by a discussion of the experiences and results obtained during field tests in snow, soft soil, and uniform coarse-grained stamp sand. During the tests the Bevameter was pushed by a Pole Cat vehicle, which also carried the hydraulic power unit and the required instrumentation. The winter and summer tests demonstrated that the wheeled Bevameter was capable of producing soil strength data; however, a number of mechanical problems were encountered requiring correction before a complete evaluation could be performed. These required modifications are: (1) installation of idlers on the chain drives for the shear wheels; (2) redesigning of the load-sinkage controls; and (3) redesigning of the shear wheel speed control. It was concluded that even if the wheeled unit were modified to work properly, the cost and time required for transportation of the equipment and setup, compared with that for hand-operated units, made the wheeled unit economically impractical. K.W.

N67-31932# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

UNUSUAL VEHICLE AND COMPONENT CONCEPT

R. A. Liston *In its* Soil-Vehicle Mech. Nov. 1966 p 279–319 refs (See N67-31921 18-11)

The general requirements considered in this study in connection with off-road vehicle performance are soft soil, geometric obstacles, hard and rough ground, vegetation, and water obstacles. The basic theoretical approach to the problems posed by each of these requirements is briefly discussed; this is followed by an examination of concepts that satisfy some of these requirements. Construction and capabilities of the Cobra concept are described, which is a three-unit, articulated vehicle having a spaced-link track. Explained in connection with the Cobra vehicle is the inching principle, which utilizes the articulation joint as a mechanism to prevent soft soil immobilization. Possible application of the flexible frame to lunar and earth vehicles is considered. The Daddy Long Legs vehicle is discussed as an example of a walking device, and experiences with a force feedback control system for such a vehicle are reported. The review of unusual vehicle components includes the concentric-dual (condual) tire, wheel concepts based on the use of a flexible rim, the hubless wheel, and the elliptical wheel. K.W.

N67-32027# Stanford Univ., Calif. Linear Accelerator Center.

TWO-MILE ACCELERATOR PROJECT Quarterly Status Report, 1 Jul.–30 Sep. 1966

Mar. 1967 99 p refs

(Contract AT(04-3)-400; AT(04-3)-515)

(SLAC-71) CFSTI: HC $3.00/MF $0.65

A report is presented on the Stanford Linear Accelerator Center during July 1, 1966 to September 30, 1966. Topics include the physical plant, accelerator physics, instrumentation and control, electronics, klystrons, accelerator operations, research area, and preoperations research and development. NSA

N67-32104# Los Alamos Scientific Lab., N. Mex.

COMPENSATION OF THE EFFECTS OF OFF-RESONANCE IN THE RESONANT CAVITIES OF ACCELERATORS [COMPENSAZIONE DEGLI EFFETTI DEL DISACCORDO NELLE CAVITA RISONANTI DELLE MACCHINE ACCELERATRICI]

D. Fabiani and M. Puglisi 24 May 1966 28 p refs Transl. into ENGLISH of Comitato Nazl. per L'Energie Nucl. Report LNF-66/28

(LA-TR-66-62; LNF-66/28) CFSTI: HC $3.00/MF $0.65

Resonators are used in storage rings to maintain the particles in orbit. The amplitude and the phase of the electric field must be kept constant in these resonators. The difficulties encountered are examined. A simple solution for these problems is indicated. The functioning of the final amplifier–cavity group is analyzed, and a correction circuit is given. Experimental results indicate that this control circuit makes it possible to compensate completely the effects of dephasing on the amplitude and phase of the input voltage. NSA

N67-32183# European Space Technology Center, Delft (Netherlands).
VACUUM CONDITIONS AND THEIR ATTAINMENT IN THE LABORATORY
In its Spacecraft Technol. Vol. V Dec. 1966 68 p refs *Its* Lecture No. 41 (See N67-32181 18-31)

The behavior of gasses and their interaction with metal surfaces, and the apparatus for the laboratory production of and maintenance of a vacuum are discussed. The velocity distribution, diffusion, and mean free path are reviewed with respect to the kinetic theory of gases. Weight losses and tensile strength changes of metals, alloys, and inorganic materials in equilibrium with their vapors are considered. Weight losses in organic materials due to evaporation are also described, and physical and chemical adsorption and absorption are discussed. Details on various pumping systems are presented, along with their characteristics. Several pressure measuring gauges and gas analyzers, and leak detectors are compared. N.E.N.

N67-32185# European Space Technology Center, Delft (Netherlands).
THERMAL ENVIRONMENT SIMULATION
L. A. Husain *In its* Spacecraft Technol. Vol. V Dec. 1966 18 p refs *Its* Lecture No. 43 (See N67-32181 18-31)

Thermal tests are considered to be the most important environmental test programs for spacecraft, and details are presented on soak tests and solar simulation. Two main soak tests are described; the environmental and the thermal vacuum tests. Solar simulation for an in-orbit environment and the difficulties involved are discussed. Particular attention in the solar simulation is given to the problems connected with the vacuum chamber, simulated solar source, chamber calibration, and radiation detection. Two space environment simulators are briefly described. N.E.N.

N67-32368*# General Electric Co., Syracuse, N. Y. Electronics Lab.
MODIFICATIONS TO INTERIM VISUAL SPACEFLIGHT SIMULATOR Quarterly Report, 12 Jan.–12 Apr. 1967
20 Apr. 1967 14 p
(Contract NAS9-3916)
(NASA-CR-65659; QR-9) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A program focusing on the design, fabrication, and installation of additions and modifications to the interim visual spaceflight simulator located at the NASA Manned Spacecraft Center, Houston, Texas; is reported. The additions and modifications comprise: (1) addition of a three-dimensional object-generating capability; (2) addition of the capability for independent operation of the three displays; (3) increased brightness, improved convergence, and higher resolution; (4) addition of a rendezvous vehicle beacon; and (5) addition of input–output equipment. Efforts have resulted in the completion of almost all major design and assembly tasks, and the commencement of the checkout of all individual units. As part of the checkout process, the significant demonstration of a simulated forty-eight edge lunar module, dynamic and in full color, was performed using actual system hardware. Cost and schedule problems which occurred are also discussed. S.C.W.

N67-32374*# General Electric Co., Philadelphia, Pa. Re-Entry Systems Dept.
ASSEMBLY/STERILIZER FACILITY FEASIBILITY PROGRAM Final Report, Volume II: Appendices
21 Feb. 1967 227 p
(Contract NAS1-5381)
(NASA-CR-66440; Doc.-67SD604, Vol. II) CSCL 14B

Data are presented on the manipulation testing, sterilization verification, and feasibility demonstration of an assembly/sterilizer (A/S) facility, or ultrabiocleen room, for the decontamination and sterilization of spacecraft, and with the capability for subsequent checkout, adjustment, repair, and encapsulation in a biological barrier under sterile conditions. Techniques for bioassay of the in-process test sample and of the clean work areas are described. In studying the human factors involved, attention was centered on work performed on typical flight hardware and test samples both inside and outside the A/S simulator. A preliminary design study and engineering design analysis of a full scale A/S facility were conducted to demonstrate the feasibility of the concept and to resolve major questions about the practicability of constructing a facility to implement the concept. M.G.J.

N67-32539# RAND Corp., Santa Monica, Calif.
AUTOMATIC CHECKOUT OF SPACE SYSTEMS
Lawrence T. Mast May 1967 17 p refs
(P-3603; AD-652458) CFSTI: HC $3.00/MF $0.65

The extent of automation and the timing of its introduction in AGE should be the result of cost-effectiveness studies. The test plan, man-machine capabilities and limitations, alternative approaches, costs, and schedule influences should enter this study. The introduction of automatic AGE involves risks to the mission-success rate of a system. Moreover, the installation and checkout of automatic AGE is usually a troublesome, costly process. To minimize these dangers, a building-block approach to automation of AGE is recommended. The future will reveal an increasing use of automation in checkout and other launch-related areas. To accomplish this, exploitation of integrated circuits in onboard checkout equipment, extensive use of digital computation equipment, and advances in programming are needed. Integrated circuits with their impact on digital equipment and onboard checkout equipment are essentially with us. Large programming advances appear to be possible in the near future. TAB

N67-32555*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF 10-KILOWATT-CARBON-ARC SOLAR RADIATION SIMULATOR
Gary C. Goldman and Kenneth Yass Washington, NASA, Aug. 1967 9 p refs
(NASA-TM-X-1411) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A commercially available 10-kilowatt-carbon-arc solar-radiation simulator was evaluated. The simulator used molded lenticular lenses to improve irradiance uniformity, and a nonconsumable tungsten negative electrode was used to provide long-term continuous operation. The following solar simulation parameters were measured: irradiance, uniformity of irradiance, spectral energy distribution, uniformity of spectral energy distribution, collimation, irradiance stability, and radiant efficiency. Author

N67-32565# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
A STAND TO TEST MATERIALS FOR CREEP IN AN ULTRASONIC FIELD
Ye. G. Konovelov and E. I. Remizovskiy *In its* Acad. of Sci. of the Belorussian SSR, Phys. and Technol. Inst. Collection of Sci. Papers 2 Sep. 1966 p 7–12 refs (See N67-32543 18-17)

This article describes a stand to test for creep with the imposition of ultrasonic oscillations and gives certain results from

an ivestigation of the effect of prior ultrasonic oscillations on the creep characteristics of D16T aluminum alloy, as delivered, at 250°C. Author

N67-32567# Rocket Meteorological Office, Thumba (India).
THUMBA MET ROCKET LAUNCHING FACILITY, KERALA, INDIA
M. S. V. Rao [1967] 8 p

Geographical and climatological data are presented on the Thumba Rocket Launching Base, and on the range instrumentation and facilities which are available for meteorological rocket launchings. These include a Judi-Dart rocket launcher, a mobile radar system, a 200-ft tower with distant indicating wind direction and speed instruments, and full facilities for computing ballistic winds and launcher settings. M.G.J.

N67-32589# Houston Univ., Tex. Dept. of Mechanical Engineering.
BALANCING CRITERIA AND THEIR RELATIONSHIP TO CURRENT AMERICAN PRACTICE
D. Muster and B. Flores Mar. 1967 69 p refs
(Contract Nobs-88657)
(TR-3; AD-652831) CFSTI: HC $3.00/MF $0.65

The results of a survey on acceptable residual specific unbalance are discussed in the context of existing balancing criteria. The study includes a statistical analysis of the data received. The results are divided in two subclasses of information according to rotor-use and rotor-weight for the purpose of grouping quantitative data for similar rotors. Author (TAB)

N67-32580# Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
DASA-AEC LOVELACE FOUNDATION BLAST SIMULATION FACILITY
Donald R. Richmond, Charles S. Gaylord, Edward G. Damon, and R. V. Taborelli Aug. 1966 44 p refs
(Contract DA-49-146-XZ-372)
(DASA-1853; AD-653021) CFSTI: HC $3.00/MF $0.65

The DASA-AEC-Lovelace Foundation Blast-Simulation Facility for the biomedical investigation of the effects of blast and shock is described in detail. Photographs, descriptions, and specifications of four air-driven shock tubes, ranging from 12 to 72 inches in diameter, and a concrete-pad, high-explosive test site are given. The instrumentation system and shock-tube and gauge-calibration procedures are included. Test parameters for each shock tube are briefly summarized and supported by typical pressure-time patterns and calibration curves. Author (TAB)

N67-32633# General Electric Co., Schenectady, N. Y.
MOLECULAR FLUX DISTRIBUTION IN AN AEROSPACE CHAMBER
D. A. Hollaboer, D. J. Santeler (Aerovac Corp.), and C. A. Tsonis [1963] 22 p refs Presented at 4th Ann. Symp. on Space Environ. Simulation, 22–23 May 1963
(Contract AF 40(600)-954) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A simple mathematical model of a space simulator, consisting of a spherical test vehicle located concentrically within a spherical chamber, is described, and the gas distribution patterns and irregularities are determined. Only condensible gasses with high sticking coefficients on the pumping panels are considered. Among the conclusions are the following: (1) Large variations in incident flux on vehicle surface are likely to exist in the simulator. (2) A probability matrix, relating the incident flux pattern on the vehicle to the gas flux pattern emitted from the wall, enables a set of gauges on the chamber wall to yield data to obtain the pattern and intensity of gas flux on the vehicle. N.E.N.

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-31557* National Aeronautics and Space Administration, Washington, D. C.
CRITICAL REVIEW OF EXPERIMENTAL HEAT TRANSFER COEFFICIENTS AND TEMPERATURE DISTRIBUTIONS IN TURBULENT BOUNDARY LAYERS AT SUPERSONIC AND HYPERSONIC FLOW [KRITISCHE DURCHISCHT EXPERIMENTELLER WAERME-UEBERGANGSZAHLEN UND TEMPERATURVERTEILUNGEN IN TURBULENTEN GRENZSCHICHTEN BEI UEBERUND HYPERSCHALLSTROEMUNG]
J. C. Rotta May 1967 32 p refs Transl. into ENGLISH of a paper presented at the AGARD Meeting on Recent Develop. in Boundary Layer Res., Naples, 10–14 May 1965
(NASA-TT-F-10905) CSCL 20D

Simple formulas to predict the heat transfer coefficients and temperature distributions of turbulent boundary layers are reviewed. On the basis of these theories, available experimental data are compared and turbulent Prandtl numbers are calculated from the experimental survey data. It is shown that boundary layers on wind tunnel nozzle walls differ greatly in their behavior from flat plate boundary layers. However, the experimental data are not free of discrepancies. No evidence can be furnished that the Crocco relation provides a satisfactory approximation to the temperature distribution in supersonic turbulent boundary layers with heat transfer. Author

N67-31667# Library of Congress, Washington, D. C. Aerospace Technology Div.
UNSTEADY MOTION OF COMPRESSIBLE MEDIA WITH BLAST WAVES
I. Soukhanov *In its* Foreign Sci. Bull., Vol. 3, No. 5 May 1967 p 1–10 refs (See N67-31666 18-34)

The findings of a Soviet research group making theoretical investigations of unsteady motion of compressible media, specifically blast dynamics in a gas and in water are summarized. Author

N67-31736* National Aeronautics and Space Administration, Washington, D. C.
CALCULATION OF CONVECTIVE HEAT TRANSFER AT SUPERCRITICAL PRESSURE [RASCHET KONVEKTIVNOGO TEPLOOBMENA PRI SVERKHKRITICHESKOM DAVLENII]
N. I. Melik-Pashayev Jul. 1967 15 p refs Transl. into ENGLISH from Teplofiz. Vysokikh Temperatur (USSR), v. 4, no. 6, 1966 p 853–864
(NASA-TT-F-11099) CSCL 20D

Derivation of analytical equations for calculating convective heat transfer in a fluid flow under supercritical pressure. A two-layer viscous-turbulent flow model, a flow with constant physical properties, and a flow with variable physical properties are considered. The convective heat transfer of a stabilized turbulent flow of a chemically homogeneous liquid in circular channels under supercritical pressure is discussed specifically. Author

N67-31796*# LTV Aerospace Corp., Dallas, Tex. Research Center.
INJECTION OF A DRAG-REDUCING FLUID INTO TURBULENT PIPE FLOW OF A NEWTONIAN FLUID
C. Sinclair Wells, Jr. and Jack Spangler Washington, NASA, Jul. 1967 21 p refs
(Contract NASw-729)
(NASA-CR-852; Rept.-0-71000/7R-4) CFSTI: $3.00 CSCL 20D

A series of experiments, in which dilute solutions of drag-reducing fluids were injected into turbulent pipe flow of a

Newtonian fluid, were performed in order to determine whether the presence of the additive only in the wall region could produce significant local shear stress reduction. It was found that the local pressure gradient could be reduced by an amount comparable to the flow of a uniform concentration when the fluid was injected in the wall region. Conversely, when the fluid was injected into the turbulent core no reduction in local pressure gradient occurred until the fluid diffused into the wall region. The effects of the injection flow process and the injection apparatus were evaluated and found to be small compared to the results of injection of the drag-reducing fluid. Author

N67-31834 Societe Bertin et Cie, Plaisir (France).
THE CURVED WALL EFFECT
M. Kadosch 5 Jan. 1967 12 p refs Presented at the 2d Cranfield Fluidics Conf., Cambridge, 3–5 Jan. 1967
(A4)

The curved wall effect or deflection of a jet of width h and Reynolds number Re attached to a convex wall of radius r is calculated as an effect of the separation of the boundary layer along the wall. Formulas are given both for laminar and turbulent boundary layers which agree with the author's experimental results although these are incomplete. Theory indicates an influence of the Reynolds number and predicts that the curved wall effect should disappear in the laminar case. Author

N67-31854* Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
ON THE IONIZED LAMINAR BOUNDARY LAYER EQUATIONS
R. J. Tabaczynski and M. E. Goldstein [1967] 9 p refs
(Grant NGR-22-009-052)
(NASA-CR-85974) CSCL 20D

The results of previous work on a new formulation of the multicomponent boundary layer problem, which was developed by a modification of the usual Chapman–Enskog procedure, are extended here to include two temperature ionized gases. Calculations are performed for the equilibrium thermal conductivity of partially ionized argon to test the set of electron and particle transport equations. L.S.

N67-31879 Bristol Univ. (England).
INVESTIGATION OF THE SWITCHING MECHANISM IN A LARGE SCALE MODEL OF A TURBULENT REATTACHMENT AMPLIFIER
P. A. Lush 5 Jan. 1967 17 p Presented at the 2d Cranfield Fluidics Conf., Cambridge (England), 3–5 Jan. 1967
(A1)

A theory based on turbulent jet entrainment properties and the assumption of quasi-steady flow is presented for the prediction of switching times in a turbulent reattachment fluid amplifier. The predictions are compared with experimental results obtained by measuring pressures during the switching action. The model used in the experiments had a throat width of 1.0 in. (25 mm) and a main jet Reynolds No. of 9×10^4. The agreement between the theoretical and experimental results was generally good. Author

N67-31988*# Toronto Univ. (Ontario). Institute for Aerospace Studies.
REFRACTION OF SOUND BY JET FLOW AND JET TEMPERATURE. EXTENSION OF TEMPERATURE RANGE PARAMETERS AND DEVELOPMENT OF THEORY
E. Grande Washington, NASA, Aug. 1967 82 p refs
(Grants NsG-661; AFOSR-672-64; NRC-A2003)
(NASA-CR-840; UTIAS-TN-110) CFSTI: HC $3.00/MF $0.65 CSCL 20A

The refraction of the sound field of an omnidirectional pure tone point source of sound by the temperature and velocity fields of a 3/4" air or nitrogen jet was measured. Several different sound source positions were employed; one within the potential core of the jet, others off the axis, entirely outside the jet. For the source in the on-axis position, the air jet velocity was varied between M = 0.5 and 0.95 at a fixed source frequency and at ambient jet temperature, yielding a characteristic axial refraction valley. Using a very cold nitrogen jet (T = −180°C), the sound was found to be refracted inward—a focusing or channelling effect—to yield a maximum intensity along the jet axis; the maximum increased with source frequency and decreased with increasing jet velocity. For the source in the off-axis positions, varying the air jet velocity between M = 0.3, and M = 0.9, intensity polars were obtained very similar to those for on-axis source position, except for a certain skewness resulting from the non-symmetrical source position. Jet noise polar directional plots at varying filter frequencies and jet velocities were obtained both for the air jet at ambient temperature and the nitrogen jet at T = −180°C. The jet noise polar plots in frequency bands were 'corrected' for refraction and convection to yield the approximate 'basic directivity' of the eddy sources. Author

N67-32108# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
THE TOMS PHENOMENON—TURBULENT PIPE FLOW OF DILUTE POLYMER SOLUTIONS
Preetinder Singh Virk (Ph.D. Thesis) 15 Nov. 1966 454 p refs
(Contract Nonr-3963(10))
(AD-651767) CFSTI: HC $3.00/MF $0.65

Drag reduction caused by dilute, distilled water solutions of five polyethylene oxides, molecular weights from 90,000 to 6,000,000, in turbulent pipe flow was studied experimentally in 0.292 cm and 3.21 cm ID pipes. It was found that: The onset of drag reduction occurs at a wall-defined wall shear stress related to the random coiling effective diameter of the polymer by the Onset Hypothesis. Laminar to turbulent transition is not, in general, delayed. The extent of drag reduction induced by a homologous series of polymers in a given pipe is a universal function of concentration, uniquely related to flow rate and molecular weight. The maximum drag reduction possible is limited by a universal asymptote that is independent of polymer and pipe diameter. In polymer solution, both the stagnation pressure attained with Pitot tubes and the heat transfer from cylinders in cross flow are drastically different from Newtonian; in general, both are lower. Author (TAB)

N67-32113*# Scientific Translation Service, La Canada, Calif.
FLOW OF A VISCOUS FLUID BETWEEN FIXED AND BLOWN ROTATING DISKS [TECHENIYA VYAZKOY ZHIDKOSTI MEZHDU NEPODVIZHNYM I OBDUVAYEMYM VRASHCHAYUSHCHIMISYA DISKAMI]
L. A. Dorfman May 1967 9 p Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekhan. Zhidkosti i Gaza (Moscow), no. 2, Mar.–Apr. 1966 p 86–91
(Contract NASw-1496)
(NASA-TT-F-10931) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Discussions are presented on the problem of motion of a viscous incompressible fluid in the interspace between an infinite rotating plane and a parallel fixed permeable plane through which supplementary fluid is injected at a constant rate. The problem is solved by solving a system of Navier–Stokes equations. Author

N67-32169# Lockheed Missiles and Space Co., Palo Alto, Calif.
INVESTIGATIONS OF THE OSCILLATIONS OF THE BASE PRESSURE BEHIND A CONE IN A SUPERSONIC FLOW
Yu. A. Panov, A. I. Shvets, and A. M. Khasen [1967] 12 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Mekh. Zhid. i Gaza (Moscow), no. 6, 1966 p 129–134
(Rept.-67-169)

Results of measurements of the oscillations of base pressure behind cones in a supersonic flowing gas, are presented. The oscillation of the model itself was recorded on an oscillograph with the aid of two strain gauges fastened on side holders. The cones had an angle of half aperture of 10° and changeable tail parts with base diameter d = 100, 130, and 150 mm fastened into the working part of a setup on two thin sharp arrow-shaped holders arranged in a vertical plane. The influence of different parameters, and of increasing the diameter cone, on the amplitude values, was studied. L.S.

N67-32177 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ANALYSIS OF SHOCKS IN WATER. REFLECTION OF A PLANE SHOCKWAVE FROM A RIGID WALL
A. A. Egorshin [1966] 4 p refs Transl. into ENGLISH from Samoletostr. i Tekhn. Vozdushn. Flota (Khar'kov), no. 7, 1966 p 96–99

Continuing research on the analysis of shock waves in water is presented, and the dependence of the reflection coefficient is obtained for shocks with a pressure amplitude up to 6500 ata. The method employs Hugoniot and Poisson adiabats. It is also shown that the reflection coefficient has a value of 2 for the linear acoustic theory. N.E.N.

N67-32270 Siemens and Halske A. G., Munich (West Germany).
FLOW STABILITY IN BI-STABLE FLUID ELEMENTS
A. W. Rechten 5 Jan. 1967 15 p refs Presented at the 2d Cranfield Fluidics Conf., Cambridge, England 3–5 Jan. 1967
(B6)

Pressure recovery in bi-stable fluid elements can be increased by stationary latching vortices. These are formed when the elements are suitably shaped, and stabilize the assigned direction of the flow. Optimum shape, size and configuration of the vortices are discussed, and a comparison is made with experimental results obtained with models, using the water table. Author

N67-32275# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
SIMILARITY SOLUTIONS FOR THE RETARDED COMPRESSIBLE BOUNDARY LAYER WITH HEAT AND MASS TRANSFER
Karlheinz O. W. Ball Mar. 1967 22 p refs
(ARL-67-0054; AD-653181) CFSTI: HC $3.00/MF $0.65

Similarity solutions are presented for the compressible laminar boundary layer with adverse pressure gradients showing the quantitative effect of heat and mass transfer on the wall shear and temperature gradient. Two suction parameters as well as wall temperatures ranging from absolute zero to twice the free-stream stagnation temperature are investigated for numerous adverse pressure gradients. TAB

N67-32286 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
BLOCK DIAGRAMS OF MEASUREMENTS OF PARAMETERS OF FLOWS WITH THE HELP OF THERMISTORS
A. G. Shashkov *In its* J. of Eng. Phys. 17 Mar. 1967 p 39–46 refs (See N67-32281 18-34)

Block diagrams are presented of measurements of velocity and temperature and their turbulent fluctuations. These diagrams are the basis of dynamic calculations of real metering systems. All elements of block diagrams are easily calculated or determined experimentally. Author

N67-32287 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF TEMPERATURE CONDITIONS ON STABILITY OF ROTATIONAL MOTION OF A LIQUID
S. K. Aslanov *In its* J. of Eng. Phys. 17 Mar. 1967 p 47–52 ref (See N67-32281 18-34)

Nonviscous stability of fluid flow in a space between two rotating coaxial cylinders at different temperatures is examined. Author

N67-32329*# Case Inst. of Tech., Cleveland, Ohio. Engineering Div.
LAMINAR FLOWS IN POROUS ELASTIC CHANNELS
Eric F. Grabowski and Simon Ostrach Jun. 1967 127 p refs
(Grant NGR-36-003-088)
(NASA-CR-86983; FTAS-TR-67-17) CFSTI: HC $3.00/MF $0.65
CSCL 20D

The nature of laminar flows of viscous fluids in porous elastic channels is examined. It is shown that for a wide range of such flows the importance of inertia effects is governed by the modified inlet axial Reynolds number. The significance of two other parameters important to these flows is also discussed. One, the ratio of a Reynolds number for the flow through the porous walls to the modified inlet axial Reynolds number, describes the degree to which wall porosity affects the axial flow. The other, a combination of this Reynolds number ratio, the ratio of the characteristic normal (vertical) wall displacement to the unstressed channel half-thickness, and the Strouhal number, governs the relative importance of normal wall unsteadiness and wall porosity in unsteady flows. The mathematical model is based on the thin-film blood flow observed in parallel plate artificial kidneys. Solutions are obtained for the axial and normal velocity components, the fluid pressure, and the normal wall displacement. The effects on these solutions of varying the significant dimensionless parameters governing the flow field and the normal wall displacement are discussed. Author

N67-32661# Illinois Univ., Urbana. Coordinated Science Lab.
INITIAL BEHAVIOR OF THE PSEUDO-SHOCK
S. M. Yen and B. L. Hicks May 1967 39 p refs
(Contract DA-28-043-AMC-00073(E))
(R-350; AD-652594) CFSTI: HC $3.00/MF $0.65

The behavior of the pseudo-shock at the onset and the early state of relaxation has been studied. The initial relaxation behavior of a gas of elastic spheres has been obtained by solving the Boltzmann equation by Nordsiecks Monte Carlo method for small times (during which less than one molecule in five has collided) with spatially uniform initial velocity distribution function. Calculations are reported for the Mach number M = 1,2,4, and 6. The characteristics of the relaxation of the lateral temperature and the Boltzmann function at the early stage have been compared with those of the large times (during which one molecule has collided up to six times). The initial relaxation of the lateral temperature for M = 1, 2 and 4 and for the Bolzmann flux for M = 1 are exponential and the relaxation rate for the lateral temperature seems to be independent of the Mach numbers mentioned. These findings are in agreement with those large times. However, for M = 2 and 4, the relaxation. The relaxation of the distribution function has been monitored for twelve chosen velocity bins. In most of the velocity bins, the distribution function seems to relax exponentially for the collision frequency and for two moments of the collizion integral at the onset of the relaxation (rho = 0). Comparisons have been made with the corresponding Monte Carlo results to ascertain the accuracy of the latter. Author (TAB)

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-31508*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
DISTRIBUTIONS AND LIFETIMES OF N AND No BETWEEN 100 AND 200 Km

S. N. Ghosh Mar. 1967 30 p refs
(Contract NASr-54(05))
(NASA-CR-86618; Rept.-05627-8-S) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The distribution of N atoms between the altitude range 100 and 280 km has been computed from reactions between constituent particles of the atmosphere and assuming their rate coefficients at laboratory temperature (300°K) to be constant for the whole altitude range. It is also calculated for rate coefficients varying with temperature. It has been found that the latter distribution, which is considerably different from the former, gives a reasonably good profile. Since in many cases, reactions involving loss of N-atoms lead to the production of NO molecules, the altitude distribution of NO molecules is also calculated. The computed N and NO distributions compare favorably with certain rocket experiments and laboratory data. From the loss processes, the lifetimes of N and NO are computed. Author

N67-31520*# Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics.
OSCILLATORY AND TRANSITORY EKMAN BOUNDARY LAYERS
Alan J. Faller and Robert Kaylor Jul. 1966 30 p refs
(Grants NsG-398; NSF GP-3443)
(NASA-CR-86603; BN-461) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Time variations of the wind stress over the ocean cause the boundary-layer flow to be significantly different from that of the classical Ekman spiral. Simple analytical solutions for the cases of rotating and oscillating wind stresses are presented, and numerical solutions of the transitory boundary layers for more realistic wind variations are given. These solutions are basically extensions of Ekman's spiral solutions for the cases of a constant coefficient of viscosity and his "quadratic friction-relationship", and of Fredholm's solution for the case of a step function in wind stress. The results show that the large inertial oscillations discussed by Ekman for the case of constant viscosity are even more persistent when the "quadratic friction-relationship" is applied. Author

N67-31543*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PROPOSED MODEL FOR THE INTERNATIONAL GEOMAGNETIC REFERENCE FIELD–1965
Joseph C. Cain, Shirley J. Hendricks, Robert A. Langel, and William V. Hudson Jul. 1967 47 p refs
(NASA-TM-X-55845; X-612-67-173) CSCL 08N

A best current model of the main geomagnetic field is presented as a response to a need for an "International Geomagnetic Reference Field". This model is described by a series of 120 spherical harmonic coefficients and their first and second time derivatives from an epoch 1960.0. It was derived from a sample of all magnetic survey data available from the interval 1900–1964 plus a recent global distribution of preliminary total field observations from the OGO-2 (1965-81A) spacecraft for epoch 1965.8. A duplicate data selection was made and the resulting field model compared with the first to help evaluate the minimum error. It was noted that the root-mean-square difference between the two models was about 30γ in the force components, 0.04 degrees in dip and 0.3 degrees in declination at the earth's surface for 1965.0. Author

N67-31561# Portugal. Nuclear Energy Commission, Sacavem. Div. of Chemistry and Metallurgy.
URANIUM LOSS IN MINES SUBJECT TO THE ACTION OF RAIN WATER [ESTUDOS SOBRE AS PERDAS DE URANIO NOS MINERIOS SUJEITOS A ACCAO DA AGUA DAS CHUVAS]
H. Carreira Pich, Marilia Alves, M. Antonieta Ramos, R. Hesse Ferreira, J. Trindade Elias, et al [1967] 88 p refs In PORTUGESE Presented at 4th Luso-Franco-Spanish Colloq. on Static Lixiviation of Uranium Mines, 3–7 Apr. 1967
(LFEN-NI.33(α))

Technical details on a study of four differnet uranium mines are presented. Tests of lixiviation with agitation, and tests of dilute solutions of sulfuric acid were conducted to test the action of rain water. Hot testing did not give a quantitative idea of the uranium loss, but permitted a two-way classification to be made. Acid testing did not afford definite conclusions on the action of rain water. Transl. by R.Li.

N67-31674# Library of Congress, Washington, D. C. Aerospace Technology Div.
RECENT SOVIET RESEARCH ON TROPOSPHERIC COMMUNICATIONS
Boris Doncov *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 38–51 refs (See N67-31672 18-34)

Recent theoretical and experimental studies on tropospheric radio propagation over dry land regions in the central U.S.S.R. are reviewed. The Soviet results are compared with those obtained in the West (principally in the United States) whenever possible. However, because of the different climetological conditions prevalent in these regions it is often difficult to determine the precise causes of disagreement in the data. Author

N67-31742*# GCA Technology Div., GCA Corp., Bedford, Mass.
SODIUM VAPOR EXPERIMENT Quarterly Progress Report, 1 Jan.–31 Mar. 1967
John F. Bedinger Apr. 1967 20 p ref
(Contract NAS5-3970)
(NASA-CR-85903; QPR-7) CSCL 04A

Preliminary data are presented on the results of five vapor trail payloads fired on Nike–Apache rockets from Fort Churchill, Canada. Each vapor trail was ejected within a few minutes of the firing of another Nike–Apache carrying a pitot static tube payload, in order to compare the two techniques. Vapor trail irregularities are assessed, and figures are included to show trail distortion produced during ejection, in which the striations correspond to those expected from a canister with a single orifice spinning at 7 rpm. The persistance of small scale features as the trail expands is also shown, and it is pointed out that such structure would complicate the analysis of early time trail growth. Wind hodographs are presented, with the high wind speeds above 120 km cited as an outstanding feature of the profiles. Also included is summary information on the vapor trail measurements made at Wallops Island over the past few years. M.G.J.

N67-31820*# Northrop Corp., Hawthorne, Calif.
THE MELTING OF GABBRO UP TO 45 KILOBARS
Emanuel Azmon [1967] 17 p refs
(Contract NAS7-358)
(NASA-CR-86627; NSL-67-224) CSCL 08G

The melting range of natural gabbro was determined at pressures up to 45 kilobars, using single-stage piston-cylinder apparatus and Pt–Pt–10 Rh thermocouples. The melting range is described by two curves which approach straight lines and can be defined as $T_{solidus} = 1095 + 7.82P$ and $T_{liquidus} = 1370 + 3.06P$, where T is temperature in degree Celsius and P is pressure in kilobars. At 58 kilobars and 1550°C the two curves join, forming a single melting curve. The genetic state of the rock, which can be defined as the temperature-pressure history of the process affecting the rock prior to quenching, determines whether the quench product will remain gabbro or will be obsidian, basalt, porphyry, or vitrophyric porphyry. Author

N67-31831# Travelers Research Center, Inc., Hartford, Conn.
A METHOD OF SOLUTION FOR A SYSTEM OF TWO SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS ARISING IN THE THEORY OF THE MEAN ATMOSPHERIC WAVES
M. Sankar-Rao (Council of Sci. and Ind. Res.) *In its* Res. on the Theory of Climate Mar. 1967 p 71–79 refs (See N67-31829 18-20)

The coupled system of second order ordinary differential equations and their boundary conditions are given for a quasigeostrophic model for the dynamical influence of diabatic heating on the stationary harmonics of atmospheric motion. A solution is presented, using a finite difference method in which convergence problems are not involved. N.E.N.

N67-31839*# Volt Technical Corp., Washington, D. C.
STUDY OF THE EARTH'S MAGNETIC FIELD WITH THE AID OF RADIATION BELTS [IZUCHENIYE MAGNITNOGO POLYA ZEMLI PRI POMOSHCHI RADIATSIONNYKH POYASOV]
S. N. Kuznetsov Washington, NASA, 22 May 1967 5 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), v. 7, no. 2, 1967 p 342–344
(Contract NAS5-12487)
(NASA-CR-84860; ST-GM-PF-10606) CFSTI: HC $3.00/MF $0.65 CSCL 08N

An electron belt detected during the flights of the Elektron-1 and Elektron-2 is reported. Position of this belt is explained by the existence of a ring current, and results of these observations are used to confirm the speculation that the earth's magnetic field differs little from a dipole field. The formulas for obtaining the dipole inclination to the rotation axis of the earth are given, and the coordinates of the southern magnetic dipole of the earth are found to coincide with those computed by ground data. Near the geomagnetic equator plane the shift of dipole center from the center of the earth is calculated at $d \approx 1200$ km. Therefore, the influence of the nondipole member of the magnetic field is made clearly apparent at an altitude of ≈8500 km above the surface of the earth. M.W.R.

N67-31852*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
D REGION ELECTRON DENSITY MEASUREMENTS DURING THE SOLAR ECLIPSE OF MAY 20, 1966
J. A. Kane 1 Jun. 1967 18 p refs
(NASA-TM-X-55839; X-615-67-263) CSCL 04A

Rocket and satellite observations of 1–8Å X-ray emissions indicate that the solar eclipse of May 20, 1966, occurred during a period in which the sun was moderately active. A series of small sounding rocket experiments to measure the ionospheric D region electron density profile during successive stages of the eclipse were conducted. From these measurements, together with the available X-ray data, it is concluded that 1–8Å X-rays were not the dominant source of D region ionization below 78 km. Author

N67-31853*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
IONOSPHERIC CHARACTERISTICS FROM ALTITUDE VARIATIONS OF POSITIVE ION DENSITIES
S. N. Ghosh Mar. 1967 32 p refs
(Contract NASr-54(05))
(NASA-CR-86682; Rept.-05827-8-S) CSCL 04A

Greater numbers of O_2^+ and NO^+ ions are created by charge exchange or ion–atom interchange reactions from ions originally produced by solar rays than by photoionization. This conclusion is confirmed by the observed low densities of O^+ and N_2^+ ions at night. It is proposed that the conclusion can be settled conclusively by noting the variation of positive ion densities during a flare or at an eclipse. Analysis of the data shows that each level between 100 and 280 km the total rate of production of different types of positive ions by solar rays is approximately equal to their total loss rate. Since the lifetimes of ions are small, the steady state is reached within a short time when the divergence term becomes nearly equal to zero. To understand the overall loss rates of positive ions in the ionosphere, the effective recombination coefficient of positive ions with electrons is defined in line with the effective electron recombination coefficient, and its values for various types of recombinations are given. Author

N67-31908 Joint Publications Research Service, Washington, D. C.
USE OF METEOROLOGICAL SATELLITES IN CLOUD RESEARCH
29 Jun. 1967 71 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ., no. 196, Probl. Sputnikovoy Meteorol. (Leningrad), 1966 p 3–138
(JPRS-41635; TT-67-32268) CFSTI: $3.00

CONTENTS:

1. DETERMINATION OF THE TEMPERATURE OF THE UNDERLYING SURFACE AND OF CLOUDS WITH METEOROLOGICAL EARTH SATELLITES K. Ya. Kondrat'yev, Ye. P. Novosel'tsev, and N. Ye. Ter-Markaryants p 1–23 refs (See N67-31909 18-13)

2. PARAMETERIZATION OF TELEVISION IMAGES OF CLOUDINESS ON DIGITAL COMPUTERS Yu. S. Fridman and V. Ye. Gol'din p 24–32 refs (See N67-31910 18-13)

3. EXPERIMENTAL INVESTIGATIONS OF THE SPECTRAL BRIGHTNESS CHARACTERISTICS OF CLOUDS, THE ATMOSPHERE AND THE UNDERLYING SURFACE IN THE 0.3–2.5 MICRON BAND C. I. Chapurskiy p 33–44 refs (See N67-31911 18-13)

4. THE POSSIBILITY OF TRACKING CLOUDINESS ON THE NIGHT SIDE OF THE EARTH FROM METEOROLOGICAL SATELLITES L. V. Murav'yeva and N. Ye. Ter-Markaryants p 45–65 refs (See N67-31912 18-13)

N67-31909 Joint Publications Research Service, Washington, D. C.
DETERMINATION OF THE TEMPERATURE OF THE UNDERLYING SURFACE AND OF CLOUDS WITH METEOROLOGICAL EARTH SATELLITES
K. Ya. Kondrat'yev, Ye. P. Novosel'tsev, and N. Ye. Ter-Markaryants *In its* Use of Meteorol. Satellites in Cloud Res. 29 Jun. 1967 p 1–23 refs (See N67-31908 18-13)

An examination is made of the factors determining errors in measuring the temperature of the underlying surface and of clouds with artificial earth satellites in various spectral intervals (3.5–4.0 and 8.0–12.0 microns). On the basis of calculation of the radiation temperature for 25 points in the USSR in different seasons, very probable corrections are proposed for the temperature of the underlying surface measured with meteorological satellites. Author

N67-31910 Joint Publications Research Service, Washington, D. C.
PARAMETRIZATION OF TELEVISION IMAGES OF CLOUDINESS ON DIGITAL COMPUTERS
Yu. S. Fridman and V. Ye. Gol'din *In its* Use of Meteorol. Satellites in Cloud Res. 29 Jun. 1967 p 24–32 refs (See N67-31908 18-13)

A first attempt has been made to solve the problem of parametrization of cloud systems obtained with television cameras installed aboard artificial earth satellites. Several general methods of mathematical processing of data on the brightness of cloud systems after their photometric measurement are proposed. Author

N67-31911 Joint Publications Research Service, Washington, D. C.

EXPERIMENTAL INVESTIGATIONS OF THE SPECTRAL BRIGHTNESS CHARACTERISTICS OF CLOUDS, THE ATMOSPHERE AND THE UNDERLYING SURFACE IN THE 0.3–2.5 MICRON BAND

L. I. Chapurskiy *In its* Use of Meteorol. Satellites in Cloud Res. 29 Jun. 1967 p 33–44 refs (See N67-31908 18-13)

The spectral brightness contrasts between clouds and snow were measured. On the basis of that data a calculation was made of the spectral reflecting capacity of cloud formations. The variation of the brightness of dust above the surface of water with height was investigated, the angular structure of the field of radiation under a continuous cloud formation was measured, and an experimental evaluation of the polarization characteristics of clouds was made. The experimental data are compared with the theoretical calculations. Author

N67-31912 Joint Publications Research Service, Washington, D. C.

THE POSSIBILITY OF TRACKING CLOUDINESS ON THE NIGHT SIDE OF THE EARTH FROM METEOROLOGICAL SATELLITES

L. V. Murav'yeva and N. Ye. Ter-Markaryants *In its* Use of Meteorol. Satellites in Cloud Res. 29 Jun. 1967 p 45–65 refs (See N67-31908 18-13)

The intensities of the effluent radiation in a cloudless sky and in the presence of clouds of various levels in the 8–12 micron water vapor window for 24 points of the Soviet Union. The values of contrast between the radiation temperatures of the underlying surface and of clouds were calculated. The possibility of detecting cloudiness on the night side of the earth from meteorological satellites was investigated. Author

N67-31922# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

RECENT INVESTIGATIONS OF VERTICAL LOAD-DEFORMATION CHARACTERISTICS OF SOILS

E. Hegedus and R. A. Liston *In its* Soil-Vehicle Mech. Nov. 1966 p 2–20 refs (See N67-31921 18-11)

A general theory for soil–vehicle systems was developed based on the Bekker method for off-the-road vehicle performance evaluation using plate penetration tests to predict vehicle sinkage and motion resistance. The approach is primarily experimental. A number of requirements necessary for correct application of the plate test are examined in this article, among them: (1) a good fit of experimental load-sinkage curves with an equation involving soil properties and plate geometry; (2) maintaining a minimum rate of penetration, above which pressure–sinkage curves are the least effected by the speed of penetration; and (3) knowledge of size and shape effects in order to produce the same parameters in a soil with arbitrarily selected plates or, if this requirement cannot be met, extrapolation of plate test results to loading areas having different size and form. It is concluded that the Bekker equations continue to be the best method for investigating load–sinkage problems in frictional, frictional–cohesive, and cohesive soils. K.W.

N67-31923# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

HORIZONTAL SHEAR IN SOIL VEHICLE MECHANICS

B. M. D. Wills *In its* Soil-Vehicle Mech. Nov. 1966 p 21–45 refs (See N67-31921 18-11)

Reviewed in this article are the methods available to the civil engineer for measuring soil shear strength against the background of soil vehicle mechanics. The translational or direct shear box test for laboratory investigations of sandy soils is discussed. Advantages, problems, and the required equipment for the torsion shear test on solid and annular cylindrical specimens are examined. The triaxial shear test is considered to be the most accurate method for determining the maximum shearing resistance and the stress–strain relationship of the specimen up to failure. These standard methods are essentially laboratory experiments, and attempts to measure soil shear strength in the field are described. Application of the methods to establish the soil shear stress–deformation relationship for predicting the overall performance curve of a wheeled or tracked vehicle is discussed at length. The theoretical emphasis of the article is on the equations of Bekker for describing all the possible forms of the experimental shear stress deformation curve, and on subsequent modifications of these equations by Reece. K.W.

N67-31925# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

STATE-OF-THE-ART OF THE ANALYSIS OF SOFT SOIL PERFORMANCE OF WHEELS

Z. J. Janosi *In its* Soil-Vehicle Mech. Nov. 1966 p 121–151 refs (See N67-31921 18-11)

Reviewed and evaluated are recent works on such topics as normal and shear stress measurements along wheel–soil interfaces, the slip–sinkage problem, mechanics of rigid wheel–soft soil systems, motion resistance due to soil compaction, and an equation for traction as a function of slip for a tire–wheel combination. Uniform stress distribution on nonfrictional soils is discussed, which was measured by means of a steel wheel equipped with a normal-pressure sensitive cell and an instrument that registered tangential forces. Described is a method for analyzing the equilibrium of a powered wheel, using the concept of the coefficient of rolling resistance. Additional summaries are presented of a study covering the flow of sand past a rigid wheel and the normal pressure distribution under the wheel, and rigid wheel tests involving transducers to measure tangential and normal stress distributions along the contact surface. K.W.

N67-31927# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

DIMENSIONAL ANALYSIS IN LAND LOCOMOTION PROBLEMS

R. A. Liston *In its* Soil-Vehicle Mech. Nov. 1966 p 167–208 refs (See N67-31921 18-11)

The purpose of this article is to demonstrate the broad range of problems connected with the use of dimensional analyses and model techniques in studying off-road vehicle performance. Applications of dimensional analysis in two areas are reviewed: to develop model theories and techniques for the evaluation of vehicle concepts, and to study the behavior of soil subjected to large-scale deformations. The review covers analyses and scale model studies of mobility factors, rigid wheel performance, soft terrain mobility, load-sinkage relationship, nonplastic soil properties, and performance of tracked and wheeled vehicles. It is concluded that dimensional analysis is significant as a tool to develop insight into the soil vehicle system, but it is of limited value as a tool for vehicle evaluation because there is no great need to resort to the use of models in the development of land vehicles. K.W.

N67-31928# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

SOIL STRENGTH PREDICTION BY USE OF SOIL ANALOGS

William L. Harrison, Jr. and Bong-Sing Chang *In its* Soil-Vehicle Mech. Nov. 1966 p 209–241 refs (See N67-31921 18-11)

Several methods of predicting soil strength were investigated by short term studies. The study offering the greatest probability of success proposed the establishment of soil analogs using the U.S. Department of Agriculture (USDA) Soil Classification System. In order to implement the proposed approach, soils in other areas of the world must be classified in terms of the USDA system. The present study sought to determine whether the USDA system lends itself to soil strength descriptions in terms of land locomotion

parameters. Field and laboratory experiments were designed to determine the following: (1) variations in the classification of soil samples from analogous sites; (2) establishment of a unified soil value system; and (3) determination of the gross effect of the variation in soil strength parameters from analogous sites on vehicle performance predictions. Samples from sites in the northeastern and north central United States were examined for shear stress deformation, load-sinkage, moisture content, bulk density, soil disturbances, and cone penetrometer readings. From the results of the study it is concluded that the establishment of soil analogs of remote and inaccessible areas of the world is a practical approach to predicting soil strength parameters. K.W.

N67-31976# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
ISOGONIC MAP OF AUSTRALIA AND NEW GUINEA FOR THE EPOCH, 1965.0
J. Van Der Linden 1965 15 p refs
(Rept.-98) CFSTI: HC $3.00/MF $0.65

Lines of equal declination, over Australia and the Territory of Papua & New Guinea, predicted for the epoch 1965.0 are shown. The series of isogonic maps started in 1950 and published by the Bureau of Mineral Resources, Geology & Geophysics at intervals of five years is continued. Three insets on the map show: (1) isogonic lines of an area in the Indian Ocean bounded by latitudes 8 degrees to 16 degrees south and longitudes 96 degrees to 108 degrees east, (2) rate of change of declination (i.e., secular variation) in minutes per year, and (3) density of declination stations in Australia and the Territory of Papua & New Guinea. Author

N67-31981# Naval Air Development Center, Johnsville, Pa.
THE VARIATION OF SOUND VELOCITY AND TEMPERATURE IN THE NORTH ATLANTIC, VOLUME II
Steve F. Torok and Ira T. Bellew 1966 581 p ref
(NADC-AE-6710, Vol. II; AD-650100) CFSTI: HC $3.00/MF $0.65

Summary listings of sound velocity and temperature with depth and the respective gradients are presented in two volumes for the area of the North Atlantic Ocean which lies between 20 degrees N and 60 degrees N latitude and between 30 degrees W longitude and the North American Continent. Volume II contains the part between 20 degrees N and 40 degrees N. All data within the confines of Chesapeake Bay are excluded from the listings. Oceanographic data obtained from Nansen bottle casts were used in computation of sound velocity and gradients. These data include all oceanographic stations in the NODC archives within the designated area, except for those stations which were considered unsuitable and were therefore deleted. Author (TAB)

N67-31983*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
EFFECT OF MOTION ON THE ALTITUDE DISTRIBUTION OF ATMOSPHERIC DENSITY Scientific Report
S. N. Ghosh Mar. 1967 13 p refs
(Contract NASr-54(05))
(NASA-CR-86623) CSCL 04A

An expression for atmospheric density is presented which is useful in determining the motion effect of vertical waves (moving with increasing velocity along its direction of propagation and for $m/kT \times v^2 << 1$) on the altitude distribution of atmospheric density. The relative magnitude of three terms in the expression corresponding to density variation due to gravity, temperature, and atmospheric motion were obtained at 100 km altitude; and it was found that for $v = 22$ m/sec the variation of density due to the above type of motion is one tenth of that due to temperature. The vertical components of the wind and the dominant gravity waves are 6 m/sec and 1 m/sec respectively and are too small to affect the altitude distribution of atmospheric density at 100 km. L.S.

N67-31991# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
POOLE RANGE GRAVITY SURVEY, WESTERN AUSTRALIA, 1953
I. B. Everingham 1965 70 p refs
(Rept.-97)

The Fitzroy Basin lies south-east of Derby, Western Australia, and is considered to be an excellent oil-prospecting area. There are several large anticlines in the Basin and it has been the aim of the Bureau of Mineral Resources, as part of its broader policy of regional mapping, to investigate certain of these structures at depth using gravity, seismic, and magnetic methods. Seismic and gravity work on the first anticline tested (Nerrima Dome) indicated that the surface structure does not persist at depth. A gravity survey made in 1953 of an area around the Poole Range structure is described. The Pinnacle Fault was traced for about 60 miles and the survey indicated that the faulting probably dies out about 25 miles south-south-east of Fitzroy Crossing. Estimates of the throw of the fault at various points range from 6600 ft to 12,000 ft, the maximum throw being near Pinnacle Yard. The gravity survey does not clearly indicate whether the surface anticlinal structure at the Poole Range persists at depth. Author

N67-32028* Volt Technical Corp., Washington, D. C.
HIGHER ORDER SCATTERING IN THE TWILIGHT SKY ZENITH
V. G. Fesenkov 27 Jun. 1967 4 p ref Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Geofizika (Moscow), v. 174, no. 4, 1967 p 833–834
(Contract NAS5-12487)
(NASA-CR-86681; ST-AA-AI-10631) CSCL 04A

It is shown that since the influence of higher order scattering at zenith of the twilight sky may be quite significant by comparison with the brightness of primary twilight at the same point and dependent to a high degree on the assumed atmosphere structure, any judgement on the optical properties of the atmosphere on the basis of the quantity B(0, 0) is entirely void of ultimate significance. Author

N67-32035 Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
GRAVITY SURVEYS OF THE GREAT BARRIER REEF AND ADJACENT COAST, NORTH QUEENSLAND, 1954–1960
J. C. Dooley 1965 60 p refs
(Rept.-73)

A gravity survey was made in the Great Barrier Reef area in 1954, readings being taken at landing places on islands and reefs. In 1958–59 further work was done using an underwater gravity meter. The results are combined with those of adjacent land surveys and are presented as anomaly maps and a series of profiles, approximately perpendicular to the coast, showing topography, geology, and gravity anomalies. The predominant feature is a rise in gravity oceanwards, presumably associated with the thinning of the Earth's crust. With suitable assumptions as to the cause of this rise, residual anomalies corresponding to shallower geological features can be estimated. The absence of large anomalies associated with the main topographical changes suggests that these changes are not, as some authors have supposed, expressions of major vertical faults. Alternative explanations are considered, but the correct solution must await further information. The residuals generally are small, and do not suggest any large quantity of near-surface material with a marked density contrast. Author

N67-32036# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).

CAPTAINS FLAT METALLIFEROUS GEOPHYSICAL SURVEY, N. S. W., 1960

E. C. E. Sedmik 1965 63 p refs

(Rept.-96)

Geophysical surveys, using principally electromagnetic, self-potential, and gravity methods, were conducted over several areas in the vicinity of Captains Flat, New South Wales. In the South Keatings area, only very weak electromagnetic anomalies were observed and these were not confirmed by the self-potential results. In the Gourlay–Hickey and Golf Course areas, four electromagnetic anomalies were observed. The gravity survey failed to show distinct gravity anomalies that could be definitely associated with any of the electromagnetic anomalies. This suggests that any mineralisation that might be associated with the anomalies would not represent large ore reserves. Gravity traverses across the orebodies of the present mine showed a pronounced fault-type anomaly, which appears to be associated with the main lode shear in which the orebodies occur. In the Bollard area, three electromagnetic anomalies were observed. They are accompanied by self-potential anomalies, but show no correlation with the results of previous geochemical tests in the area, and are considered to be primarily due to graphitic slate. Author

N67-32069*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Space Sciences Dept.

AEROSOL SAMPLES OBTAINED FROM 9-Km TO 12-Km ALTITUDE

C. E. Melton *In* NASA, Washington Meteor Orbits and Dust 1967 p 293–299 refs (See N67-32038 18-30)

Aerosol samples have been obtained at monthly intervals in the altitude range from 9 to 12 km over the southern California area. The spatial density of all opaque particles collected ($\geq 4\ \mu$) varied widely, ranging from about 20 to 200 particles/m^3, and showed no dependence on altitude. Certain highly irregular particles have been found, but have not as yet been definitely related to meteor shower activity. No increase in the spatial density of metallic spherules was determined to be associated with meteor showers. The differential size distribution for the collected metallic spherules follows approximately an inverse fourth-power law. This distribution leads to a mass influx of 8.4×10^4 metric tons per year upon the earth. Author

N67-32073*# Air Force Cambridge Research Labs., Bedford, Mass.

EXTRATERRESTRIAL DUST CONCENTRATIONS IN THE UPPER ATMOSPHERE

R. K. Soberman *In* NASA, Washington Meteor Orbits and Dust 1967 p 323–331 refs (See N67-32038 18-30)

A theory for the mechanism of formation of noctilucent clouds is presented. It is suggested that the clouds are composed of extraterrestrial particulate matter, coated with ice, which is following a major mesospheric convection motion across the arctic twilight. Computer calculations based upon the results of particulate-sampling experiments show that mean updrafts of less than 1 m/sec could produce the particulate concentrations measured in the noctilucent clouds. It is proposed that the required persistent updraft results from the continuous solar heating of the ozone layer during the arctic summer. This updraft serves to raraise particles that have settled through the mesopause. These, combined with the enhanced influx of particles during a meteoric shower, produce a cloud of particles that follows the convective cell across the twilight to a downdraft on the dark side of the earth. The convective motion also serves to raise water vapor that condenses on the particles in the arctic mesopause. The theory explains a number of the peculiarities of noctilucent clouds, such as the times of appearance and the direction of motion, and yields predictions for future experiments. Author

N67-32078*# ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France).

CONCENTRATION OF MAGNETIC DUST IN THE STRATOSPHERE

T. Grjebine *In* NASA, Washington Meteor Orbits and Dust 1967 p 361–364 refs (See N67-32038 18-30)

The amount of magnetic dust was investigated by means of balloon-borne gauze filters and filters flown in airplanes. The concentration of dust is increased at an altitude of 20 km. A transformation of magnetic attraction into weight for a sample collected in the Alps at an altitude of 3800 m gives a concentration of 2×10^{-4} g/m^3 for that level. This is compatible with ground measurements of fallout of magnetic dust and residence time of dust in the stratosphere. Author

N67-32109# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).

GIPPSLAND BASIN AIRBORNE MAGNETIC SURVEYS, VICTORIA, 1951–52 AND 1956

J. H. Quilty 1965 35 p refs

(Rept.-95) CFSTI: HC $3.00/MF $0.65

An aero-magnetic survey was conducted of the on-shore area of the Gippsland Basin, Victoria, in 1951–52 and of the off-shore area in 1956. The anomaly trends of the aeromagnetic contour map can be correlated with several known geological structures in the Basin, some of which can be traced by their magnetic characteristics into the deeper parts of the Basin. A contour map of estimated depths to magnetic basement rock shows a trough east of Lake Wellington containing probably 15,000 feet of sediments. Depth estimates in parts of the south–western corner of the Basin are uncertain because of the presence of magnetic basalt flows in the sedimentary sequence. Author

N67-32110# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).

MAGNETIC MEAN HOURLY VALUES FROM WATHEROO OBSERVATORY, WESTERN AUSTRALIA, 1955–1956

P. M. McGregor 1966 122 p refs

(Rept.-119) CFSTI: HC $3.00/MF $0.65

Tabulated hourly and monthly mean values of the magnetic elements, and daily Fourier coefficients, derived from normal magnetograms produced at Watheroo Observatory in 1955 and 1956 are presented. It also includes a list of annual mean values 1919–1956. Author

N67-32115*# Geophysics Corp. of America, Bedford, Mass. Technology Div.

MEASUREMENT OF UPPER ATMOSPHERIC IONIZATION AND WINDS WITH A COMBINED PAYLOAD Final Report

L. G. Smith, J. F. Bedinger, G. T. Best, and E. Constantinides Jun. 1967 81 p refs

(Contract NASw-1083)

(NASA-CR-86612; GCA-TR-67-11-N) CSCL 04A

The relation between the structure of the electron density profile and of the wind in the E region is examined with particular emphasis on the wind shear theory of the sporadic E layer. The theory postulates that a layer of enhanced electron density will form at the point of zero velocity of an east–west wind shear or of the appropriate sign. The theory is presented only as a steady-state solution of the distribution equation and thus can compare only the relative positions of observed layers and wind profiles. The wind shear theory of the formation of sporadic E layers at high latitudes was observed in the auroral zone and in Brazil during the total solar eclipse of November 1966. Upper atmosphere temperatures were measured using the fluorescence spectrum of aluminum oxide, and observations of the comet Ikeya–Seki were made using a one-half meter Fastie spectrometer. S.P.

N67-32130# Boeing Co., Seattle, Wash. Geoastrophysics Lab.
PROTON DENSITIES IN THE MAGNETOSPHERE FROM PEARL DISPERSION MEASUREMENTS
H. B. Liemohn, J. F. Kenney, and H. B. Knaflich May 1967 28 p refs
(D1-82-0615; AD-652483) CFSTI: HC $3.00/MF $0.65

The dispersion characteristics of 75 pc 1 micropulsation pearls are described and analyzed. The results show that these emissions are generated on field lines with equatorial intercepts between four and nine earth radii. There is a diurnal variation in the location of the propagation paths which constitute a pearl oval with nighttime pearls propagating closer to the earth at higher frequencies than daytime pearls. This pearl oval expands to lower latitudes with an increase in the bulk velocity of the solar wind. The exospheric plasma densities derived from this research are in reasonable agreement with previous ULF and VLF results, but it appears that pearls are generated primarily on very steep density gradients that may coincide with the plasmapause already detected by VLF whistlers. Author (TAB)

N67-32168# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOVIET ANTARCTIC EXPEDITIONS, 1959–1961
A. V. Nudel'man 1966 161 p refs Transl. into ENGLISH of the book "Sovetskie Ekspeditsii v Antarktiku 1959–1961 gg." Moscow, Izd. AN SSSR, 1962 Published for NSF
(TT-65-50145) CFSTI: HC $3.00/MF $0.65

Activities of the fifth and the initial stage of the sixth Soviet Antarctic expedition during the years 1959 through 1961, are summarized. A chronological narration of the voyages of the Soviet expedition vessels in Antarctic waters, the work of Antarctic stations, and the air and tractor sledge traverses to the inner regions of the continent, is presented. Results of geophysical research on the continent; and a brief description of the organization and work of the temporary advance Antarctic stations, Druzhba, Mir, and Pobeda, are given. The basic climatic parameters of the regions where the stations are situated; coordinates; elevations; dates of inauguration and closing; calendar schedule of movements of expedition vessels; participants; and numerical composition of the expeditions, are given. L.S.

N67-32170# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOVIET ANTARCTIC EXPEDITIONS, 1955–1959
A. V. Nudel Man 1966 143 p refs Transl. into ENGLISH of the book "Sovetskie Ekspeditsii v Antarktiku 1955–1959 gg." Moscow, Izd. AN SSR, 1959 Published for Dept. of Interior and NSF
(TT-65-50146) CFSTI: HC $3.00/MF $0.65

Activities of the first, second, and third Soviet Antarctic expeditions during the years 1955 through 1959 are summarized. A chronological account of the organization of the Soviet scientific stations and tractor sledge traverses is provided, together with an enumeration of the basic facts related to the work of the expedition. Aerometeorological, geological, geophysical, and aerophotographic research activities are described, and mention is made of certain fundamental scientific conclusions obtained during the expeditions. A list of documentary films based on data from the expeditions is given.

N67-32174# Aeronautical Chart and Information Center, St. Louis, Mo.
MAGNETIC PROPERTIES OF INTRUSIVE TRAPS ON THE KUREYKA REGION [MAGNITNYYE SVOYSTVA INTRUZIVNYKH TRAPPOV KUREYSKOGO RAYONA]
V. B. Grendo May 1967 8 p Transl. into ENGLISH of the publ. "Nastoyashcheye i Proshloye Magnitnogo Polya Zemli" Nauka, Moscow, 1965 p 292–294
(ACIC-TC-1162; TT-67-62029; AD-652489) CFSTI: HC $3.00/MF $0.65

The basic problem of this work is to establish the magnetic properties of intrusive traps in order to interpret aeromagnetic and terrestrial magnetic surveys. In this article, the magnetic properties of intrusive traps in the Degen River section were examined. The intrusive bodies which are the basic subject of this study, were exposed on the surface in the form of individual cliff outcrops. Author (TAB)

N67-32261# Aerospace Medical Div. Arctic Aeromedical Lab., Fort Wainwright, Alaska.
GROUND TEMPERATURE DATA OF BIOLOGICAL SIGNIFICANCE Technical Report, Sep. 1963–Jun. 1966
John F. Lee Apr. 1967 15 p refs
(AAL-TR-67-2; AD-653180) CFSTI: HC $3.00/MF $0.65

Ground temperature studies were initiated at Fairbanks, Alaska to prove data for predicting temperatures of survival shelters warmed by radiation from the earth. Some of this data is presented here in the hope it may be interesting to investigators of mammalian microclimates. Holes to depths of 10 ft were instrumented with thermistors during September 1963 and readings were taken at regular intervals until July 1966. Insulated shelters were placed in the vicinity of instrumented holes and temperature data were obtained. Temperatures were also taken inside shelters occupied by human subjects. Instrumented shelters were placed on frozen Chena River and data obtained while unoccupied and during occupancy. Nearby thermistors were frozen to river ice under snow cover and with snow removed. Temperatures of ground surface beneath snow were -6C when ambient air was -46C. When ambient air was -40C, temperatures inside shelters were as high as -8C and when shelters were occupied temperatures were over +15C. With ambient air below -40C, temperature in unoccupied shelter on the river was -9C, under snow -8C, and where snow was removed -30C. Author (TAB)

N67-32264# Army Electronics Research and Development Activity, Fort Huachuca, Ariz. Atmospheric Sciences Lab.
DERIVATION OF HYPERBOLIC TURBULENT DIFFUSION EQUATION
Ronald E. Meyers May 1967 25 p refs
(ECOM-6026; AD-653015) CFSTI: HC $3.00/MF $0.65

A three dimensional hyperbolic differential equation based on finite correlated particle velocities is derived which is appropriate to modeling anisotropic turbulent diffusion in the atmosphere. Cauchy initial data, the mean wind, the Reynolds stress tensor, and a typical frequency of pulsation are required for complete solution. The outlines of plumes and puffs may be obtained with only knowledge of the Reynolds stress tensor and mean wind velocity. The classical parabolic diffusion equations are a limiting form of this hyperbolic model. TAB

N67-32268# Northeastern Univ., Boston, Mass.
CONSIDERATIONS OF EXPECTED AURORAL INTENSITIES
Basil L. Cochrun 28 Feb. 1967 13 p refs
(Contract AF 19(628)-3876)
(AFCRL-67-0210; SR-2; AD-652855) CFSTI: HC $3.00/MF $0.65

Using luminosity profiles and graphical integration, curves of normalized intensity versus height are obtained for arc, ray and drapery type aurorae for the 5577 (01), 6300 (01) and 4278(N+2) (0-1) emissions. Author (TAB)

N67-32324# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
SOME APPLICATIONS OF WIND TO UNGUIDED ROCKET IMPACT PREDICTIONS

Edward M. D'Arcy Mar. 1967 25 p refs
(ECOM-5112; AD-653001) CFSTI: HC $3.00/MF $0.65

The report discusses the maximum layer thickness to be used in a real-time system where the maximization results in the minimization of digital computer core storage usage but delivers the desired accuracy. Results show that small layers, on the order of the size of the rocket, need to be used in the first portion of the wind profile but can expand to quite large thicknesses at the top of the profile. The effect of winds encountered by an unguided rocket on the re-entry leg of its trajectory and the effect of winds above 100 thousand feet are discussed. Results show that winds on re-entry are never needed above 100,000 feet and only rarely below. Winds above 100,000 feet should be used if the burnout altitude of the rocket is above 100,000 feet. Author (TAB)

N67-32364# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
MAGNETIC MEAN HOURLY VALUES FROM WATHEROO OBSERVATORY, WESTERN AUSTRALIA, 1957–1958
P. M. McGregor 1966 122 p refs
(Rept.-120) CFSTI: HC $3.00/MF $0.65

Reported is the fifth and last in a series which presents tabulated hourly and monthly mean values of the magnetic elements, and daily Fourier coefficients, derived from normal magnetograms produced at Watheroo Observatory in 1957 and 1958. Also included is a list of annual mean values for the period 1919 to 1958. From January 1959, magnetic recording continued at the Gnangara site of Mundaring Geophysical Observatory. S.C.W.

N67-32365# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
MAGNETIC MEAN HOURLY VALUES FROM WATHEROO OBSERVATORY, WESTERN AUSTRALIA, 1948–1949–1950
P. M. McGregor 1966 174 p refs
(Rept.-110) CFSTI: HC $3.00/MF $0.65

Reported is the first of a series of reports which contain Watheroo results obtained since the observatory was transferred in 1947 from the Department of Terrestrial Magnetism, Carnegie Institution of Washington to the Australian Commonwealth Government. Presented are tables of hourly and monthly mean values of the magnetic elements, and daily Fourier coefficients for Watheroo during 1948, 1949, and 1950. Also listed are annual mean values from 1919 to 1950 adjusted to recent standards. S.C.W.

N67-32366# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
MAGNETIC MEAN HOURLY VALUES FROM WATHEROO OBSERVATORY, WESTERN AUSTRALIA, 1951–1952
P. M. McGregor 1966 121 p refs
(Rept.-111) CFSTI: HC $3.00/MF $0.65

Reported is the second report in a series which presents magnetic results obtained at Watheroo during the period 1948 to 1958, when the observatory was operated by the Commonwealth of Australia. Included are tables of hourly and monthly mean values of the magnetic elements for 1951 and 1952, daily Fourier coefficients for 1951 and 1952, and a summary of annual mean values from 1919 to 1952. S.C.W.

N67-32367# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
ERRORS AND LIMITATIONS OF THE MAGNETIC COMPASS
W. D. Parkinson 1965 19 p
(Rept.-92) CFSTI: HC $3.00/MF $0.65

Described are geophysical phenomena associated with the Earth's magnetic field which control the performance of the magnetic compass and impose limitations on the accuracy of the instrument. Focused on are errors in compass readings that are induced by geophysical errors, artificial fields, and instrumental errors. Also discussed are characteristics of the three main parts of the Earth's magnetic field (main, local, and external); inherent problems associated with the use of a compass in high latitudes; and the influence of local and external fields on the accuracy of isogonic maps. S.C.W.

N67-32387# Ohio State Univ. Research Foundation, Columbus.
LINEAR SOLUTIONS OF THE GEODETIC BOUNDARY-VALUE PROBLEM
Helmut Moritz Dec. 1966 143 p refs *Its* Dept. of Geodetic Sci. Rept.-79
(Contract AF 19(628)-5701)
(AFCRL-67-0044; SR-11; AD-653193) CFSTI: HC $3.00/MF $0.65

The report is concerned with formulas for the determination of the earths physical surface and external gravity field from free-air gravity anomalies to an approximation linear in the elevation and its derivatives. Part A considers integral equations and their linear solutions; Part B gives an elementary deduction of these solutions from the geometrically evident gradient solution; and the subject of Part C is an application to various gravity-dependent quantities and an evaluation of different solutions. Author (TAB)

N67-32492# Ohio State Univ. Research Foundation, Columbus.
COMPARISON OF SATELLITE GEOIDS AND ANOMALY FIELDS
Richard H. Rapp Feb. 1967 103 p refs
(Contract AF 19(628)-5701)
(Rept.-80; SR-12; AFCRL-67-0151; AD-653194) CFSTI: HC $3.00/MF $0.65

Various determinations of the harmonic coefficients in the expansion of the earths gravitational field have been compared in terms of geoids and gravity anomalies. The most recent satellite solution of Anderle agrees fairly well (when comparing common coefficients) with the Gaposchkin solution (RMS difference = plus or minus 5.9 m) but does not agree well with the recent Kaula field from combined satellite and terrestrial data (RMS difference = plus or minus 9.2 m). Estimates made of the effect of the higher-order terms on the undulation values were used to estimate the over-all accuracy figure for current solutions as plus or minus 9.9 m. The error committed by neglecting terms higher than n=8 was estimated as plus or minus 6 m; beyond n=12, plus or minus 4 m; and beyond n=15, plus or minus 3 m. Comparisons of the solutions for various size blocks showed better agreement, the larger the blocks. Accuracy estimates for mean anomaly evaluations from the current satellite solutions were: 5 degrees x 5 degrees, plus or minus 15 mgal; 10 degrees x 10 degrees, plus or minus 12 mgal; 15 degrees x 15 degrees, plus or minus 10 mgal; 20 degrees x 20 degrees, plus or minus 7 mgal; and 30 degrees x 30 degrees, plus or minus 3 mgal. Comparisons of the satellite anomalies were also made to terrestrial anomalies in 5 degrees x 5 degrees and 30 degrees x 30 degrees blocks. The 5 degree comparison was used to demonstrate a method for the determination of equatorial gravity. Author (TAB)

N67-32531# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
BLAIR ATHOL COALFIELD GRAVITY SURVEY, QUEENSLAND, 1959
F. J. G. Naumann 1965 90 p refs
(Rept.-94)

A detailed gravity survey was made at the Blair Athol coal field in East-Central Queensland, Australia to investigate a possible northern extension of the productive coal measures in order to increase the known coal reserves, and to provide data on the configuration of the basement underlying the coal measures to

assist in clarifying the tectonic setting of the basement structure as a whole. The survey showed that a distinct gravity low is linked with the main coal basin at the coal field. Distinct gravity highs on the eastern and south-eastern limb of the coal deposit indicate raised areas of basement rocks unfavorable to thick coal development. Strong gravity gradients suggest a rapid thinning of the coal measures on the north-western margin of the coal field. R.N.A.

N67-32543# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
A COMPARISON OF PIBAL WITH RAOB AND RAWIN WIND MEASUREMENTS
L. J. Rider Apr. 1967 25 p refs
(ECOM-5116; AD-653004) CFSTI: HC $3.00/MF $0.65

An empirical study of the time and space variability of winds measured by triple-theodolite pilot balloon observations (pibals) compared with radiosonde (raob) and rawinsonde wind measurements at Green River, Utah, during the months of September 1965, and June, July, and August 1966, is presented. Pibal and rawin wind measurements at 500-foot intervals from 1000 to 10,000 feet were compared with radiosonde winds, and from 6500 to 10,000 feet pibal and rawin winds were compared. Absolute mean wind direction differences decreased from 22 degrees at 1000 feet to 9 degrees at 5500 feet, and from 10 degrees at 6500 feet to 5.5 degrees at 10,000 feet. A negative bias of 9 and 8 degrees was evident at the 1000 and 1500-foot levels, respectively. Absolute mean wind speed differences ranged from 2.75 m/sec at 1000 feet to 1.5 m/sec at 3500 feet and approximately 1.0 m/sec at all levels above. Mean pibal wind speeds were greater than the raob measurements at all levels, ranging from 2.6 m/sec at 1000 feet to 1.1 m/sec at 2500 feet and near 0.5 m/sec from 3000 to 5500 feet. No significant bias between the pibal and rawin speeds was indicated. Author (TAB)

N67-32547# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
CONSTRUCTION OF THE NORMAL GEOMAGNETIC FIELD BY MEANS OF COMPUTATION [POSTROYENIYE NORMAL'NOGO GEOMAGNITNOGO POLYA RASCHETNYM PUTEM]
B. D. Vints and V. I. Pochtarev May 1967 14 p refs
Transl. into ENGLISH from the book "Nastoyashcheye i Proshloye Magnitnogo Polya Zemli" Moscow, Izd. Nauka, 1965 p 79–87
(ACIC-TC-1160; TT-67-62027; AD-652487) CFSTI: HC $3.00/MF $0.65

In the practice of both Soviet and other foreign geophysicists, two types of normal geomagnetic fields are necessary for the separation of one or another class of anomaly. These two types are the field of the uniformly magnetized sphere (TO), and the field representing the sum of the fields of uniform magnetization and of the world anomalies, TN = TO + TW. By these means the local and regional anomalies are distinguished. The translation shows charts and graphs used to set forth normal geomagnetic fields within the USSR, and the conclusions reached regarding major regional magnetic anomalies. Author (TAB)

N67-32816# Aeronautical Chart and Information Center, St. Louis, Mo. Linguistic Section.
SOME REGULARITIES IN THE BEHAVIOR OF MAGNETIC CHARACTERISTICS DEPENDING ON THE CONDITIONS OF FORMATION AND LIFE OF ROCK, BASED ON THE EXAMPLE OF FERRUGINOUS QUARTZITES OF THE KURSK MAGNETIC ANOMALY [NEKOTORYYE ZAKONOMERNOSTI POVEDENIYA MAGNITNYKH KHARAKHTERISTIK V ZAVISIMOSTI OT USLOVIY OBRAZOVANIYA I ZHIZNI PORODY NA PRIMERE ZHELEZISTYKH KVARTSITOV KMA]
T. A. Martynova May 1967 12 p Transl. into ENGLISH of the Publ. "Nastoyashcheye i Proshloye Magnitnogo Polya Zemli" Moscow, Nauka Publishers, 1965 p 147–153
(ACIC-TC-1161; TT-67-62028; AD-652488) CFSTI: HC $3.00/MF $0.65

The work is an attempt to explain to what extent the study of magnetic properties can throw light on the origin of rocks and on the geological processes to which these rocks have been subjected. The investigation was made on the ferruginous quartzites of the Kursk magnetic anomalys Storyy Oskol region. Author (TAB)

N67-32819 Slovak Academy of Sciences, Bratislava (Czechoslovakia). Geomagnetic Observatory.
RESULTS OF GEOMAGNETIC OBSERVATIONS AT THE HURBANOVO GEOMAGNETIC OBSERVATORY IN 1962
1967 71 p refs In CZECHOSLOVAKIAN; RUSSIAN and ENGLISH

Tables are presented on the geomagnetic elements of declination, horizontal intensity, and vertical intensity. Tables are also given on the mean hourly values, mean diurnal inequalities, and mean monthly and annual values of the elements. The measuring apparatus and procedures are briefly described. N.E.N.

N67-32820 Slovak Academy of Sciences, Bratislava (Czechoslovakia). Geomagnetic Observatory.
RESULTS OF GEOMAGNETIC OBSERVATIONS AT THE HURBANOVO GEOMAGNETIC OBSERVATORY IN 1963
1967 68 p refs In CZECHOSLOVAKIAN, RUSSIAN, and ENGLISH For abstract see N67-32819

N67-32631# Illinois State Water Survey, Urbana.
EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE COALESCENCE OF LIQUID DROPS Final Scientific Report
Richard G. Semonin 23 Feb. 1967 66 p refs
(Grant NSF GP-2528)

CONTENTS:

1. CLOUD DROPLET COLLISION EFFICIENCY IN ELECTRIC FIELDS H. R. Plumlee and R. G. Semonin 9 p refs
2. COLLISION EFFICIENCY OF CHARGED CLOUD DROPLETS IN ELECTRIC FIELDS R. G. Semonin and H. R. Plumlee 8 p refs
3. THE COALESCENCE DELAY TIME: EFFECTS OF VOLTAGE, VELOCITY, AND HUMIDITY R. G. Semonin 12 p refs
4. PRODUCTION OF UNIFORM-SIZED LIQUID DROPLETS N. R. Lindblad and J. M. Schneider 4 p refs
5. AN APPARATUS TO STUDY THE COLLISION AND COALESCENCE OF LIQUID AEROSOLS J. M. Schneider, N. R. Lindblad, and C. D. Hendricks 7 p refs
6. ON THE COALESCENCE AND COLLISION OF WATER DROPS R. G. Semonin and H. R. Plumlee 5 p refs
7. EFFECTS OF ELECTROSTATIC FORCES ON DROP COLLISION AND COALESCENCE IN AIR H. R. Plumlee 3 p

N67-32884# Army Natick Labs., Mass. Earth Sciences Div.
SEASONAL CHANGE REVEALED BY TIME-LAPSE PHOTOGRAPHY
Roland J. Frodigh Mar. 1967 61 p refs
(TR-67-34-ES; ES-27; AD-652732) CFSTI: HC $3.00/MF $0.65

The report demonstrates the application of time-lapse photographic techniques to a study of seasonal changes in coloration and appearance at sixteen locations in New England. The sites used to illustrate the method were selected for their representativeness of the four major physiographic regions: coastal lowland, uplands, interior lowlands, and mountains. Individual landscapes were

photographed in color during each season, recording the identical field-of-view from the same spot locations. The photography is supplemented by topographic, vegetation, and climatic maps, graphs, site data, and narrative descriptions. Factors pertaining to camouflage problems are documented photographically to illustrate significant changes in vegetation color. The combination of maximum visibility and minimum canopy coverage during periods of vegetation dormancy in forested areas is contrasted with greatly reduced visibility and nearly complete canopy coverage during the growing season. Trafficability problems in off-road areas are strikingly evident in scenes depicting winter snow accumulation and seasonal flooding in spring. Author (TAB)

N67-32692# American Meteorological Society, Boston, Mass.
INTENSITY OF RADIATION FROM AUREOLE UNDER STANDARD CONDITIONS [INTENSIVNOSTI' OKOLOSOLNECHNOI RADIATSII V STANDARTNYKH USLOVIIAKH]
G. L. Shubova Bedford, Mass., AFCRL, Apr. 1967 8 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), no. 170, 1965 p 188–191
(Contract AF 19(628)-3880)
(T-R-610; TT-67-62073; AD-653169) CFSTI: HC $3.00/MF $0.65

The intensity of radiation from aureole is estimated for standard conditions. The radiant intensity of radiation from sunward is studied as a function of the mass of the atmsophere and of the surface albedo. Author (TAB)

N67-32693# American Meteorological Society, Boston, Mass.
GROUND MEASUREMENTS OF THE ANGULAR DISTRIBUTION AND SPECTRAL COMPOSITION OF DIFFUSE SKY RADIATION [NAZEMNYE IZMERENIIA UGLOVOGO RASPREDELENIIA I SPEKTRAL'NOGO SOSTAVA RASSEIANNOI RADIATSII NEBA]
V. I. Kushpil' Bedford, Mass., AFCRL, Apr. 1967 19 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), no. 170, 1965 p 156–166
(Contract AF 19(628)-3880)
(T-R-609; TT-67-62072; AD-653168) CFSTI: HC $3.00/MF $0.65

The results of ground measurements of the sky brightness are cited for the spectral region 0.58 to 1.87 microns with various scattering angles and compared with data in the literature. Author (TAB)

N67-32698# American Meteorological Society, Boston, Mass.
RECORDING SPECTROPHOTOMETER FOR GROUND AND BALLOON MEASUREMENTS OF THE BRIGHTNESS OF THE DAYTIME SKY [REGISTRIRUIUSHCHII SPEKTROFOTOMETR DLIA NAZEMNYKH I AEROSTATNYKH IZMERENII IARKOSTI DNEVNOGO NEBA]
N. M. Gopshtein and V. I. Kushpil' Bedford, Mass., AFCRL, Apr. 1967 13 p refs Transl. into ENGLISH from Tr. Gl. Geofiz. Observ. (Leningrad), no. 170, 1965 p 149–155
(Contract AF 19(628)-3880)
(T-R-608; TT-67-62071; AD-653167) CFSTI: HC $3.00/MF $0.65

A detailed description is given of an instrument for measuring the brightness of the sky in the 0.58 to 1.87 microns region of the spectrum at heights up to 30 km. The calibration of the instrument and techniques for analysis of the measurements are also described. Author (TAB)

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-31503# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
FABRICATION OF LITHIUM-DRIFT GERMANIUM RADIATION DETECTORS
James Benedict Mullady (M.S. Thesis) Jun. 1966 55 p refs
(GSP/PH/66-13; AD-652481) CFSTI: HC $3.00/MF $0.65

A simple technique for fabricating lithium-drift germanium radiation detectors for use in gamma-ray spectroscopy is described in detail. Lithium-ion drift is conducted in room atmosphere at constant temperature and voltage for 470 hours to obtain a 2 mm thick sensitive region 7.5cm2 in area. One detector made by this method gives 10.3 kev (fwhm) resolution for the Cs137 662 kev gamma-ray. Leakage current at 77K and 65 volts reverse bias is 1.65 x 0.0000001 A. TAB

N67-31591*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DEVELOPMENT OF ELECTRONIC VISUAL INSTRUMENTATION
C. T. Huggins *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 333–346 (See N67-31562 18-09)

This paper presents the history and reasons for development of television by Marshall Space Flight Center (MSFC) for use on space vehicles. A discussion of the theory of systems used includes single and multiple camera use with a common transmitter. Component problems and their solution to meet launch as well as orbital operation requirements are discussed. Microminiaturization and development of new image devices have reduced power required, size, and weight so that a palm-size camera that will meet vibration and other requirements for launch and orbit operation is possible. Also discussed is a new imaging theory approach which replaces the vacuum type imaging tube with a solid state image converter working in a solid state camera. Author

N67-31661 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
A LOW BACKGROUND BETA SCINTILLATION COUNTER
St. Pszona and K. Zarnowiski 1967 17 p refs
(INR-780/XIX/D)

A low level scintillation counter for β counting purpose has been constructed whose mean background count rate are 0.17 cpm. at 120 keV discrimination level. The analysis of background sources of scintillation counter are reported. Author

N67-31709*# Illinois Univ., Urbana.
THEORETICAL AND EXPERIMENTAL STUDIES OF THE UNDERLYING PROCESSES AND TECHNIQUES OF LOW PRESSURE MEASUREMENT Progress Report, 1 Jun. 1966–31 May 1967
R. N. Peacock, F. M. Propst, J. W. Culton, W. C. Schuemann, D. E. Coad et al 31 May 1967 18 p refs
(Grant NsG-376)
(NASA-CR-85970) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Twelve Schuemann gauges were built and tested in an effort to make the gauge a more practical instrument for measuring very low pressures to about 10^{-13} Torr. The gauges were designed to overcome certain objections to former models, namely continued outgassing of the gauge materials and difficulty of heating by electron bombardment. Four of the tested gauges were used to gather ionization cross section data for gases at the electron energies found in the gauges related to spurious effects found in upper atmosphere measurements made from rocket probes. In addition, a feasibility study was made for a new type of absolute pressure gauge capable of detecting pressures as low as 10^{-13} Torr. The gauge uses technology which already exists for molecular beam measurements in addition to new ideas. The main applications for this gauge will be absolute calibration of ionization on other gauges below 10^{-4} Torr, or use as the primary pressure gauge for ionization cross section measurements. Other studies of vacuum gauge effects are also reported. L.S.

N67-31723*# Raytheon Co., Wayland, Mass. Advanced Development Lab.

DESIGN AND DEVELOP FAST SCAN INFRARED DETECTION AND MEASURING INSTRUMENT. PHASE IV: EXPERIMENTAL STUDY

R. Vanzetti and A. S. Dostoomian 15 May 1967 55 p (Contract NAS8-11604)

(NASA-CR-85602) CFSTI: HC $3.00/MF $0.65 CSCL 17E

Major areas of redesign evaluation for a fast scan infrared detection and measuring instrument were concerned with a target pedestal, visual microscope, optics alignment, scanning elements, detector aperture, sync pulses, signal processing electronics, calibration devices, and optimum performance tradeoffs. Measurement of dual 3 input Nand gate integrated circuits is reported, as is the testing of power transistors for second breakdown by using infrared techniques. A transistor quality evaluation is reported; temperature versus output calibration curves are discussed; and the scanning of low power transistors of the 2N3781 type (1-watt without heat sink) is described. These calibration and measurement efforts have permitted the development of techniques for the alignment of the optics of the microscope, and for convenient aiming and focusing. It was shown that future failures can be predicted by infrared scanning. M.W.R.

N67-31790# American Science and Engineering, Inc., Cambridge, Mass.

CHARGE PARTICLE TRANSMISSION THROUGH SPHERICAL PLATE ELECTROSTATIC ANALYZERS, APPENDIX D

F. R. Paolini and G. C. Theodoridis *In its* Satellite and Rocket Data Anal. 17 Feb. 1967 40 p refs (See N67-31786 18-30) (Contract AF 19(628)-5712)

The transmission characteristics of spherical plate electrostatic analyzers for external sources are studied. Transmission as a function of particle point of incidence, angle of incidence, kinetic energy, and of analyzer plate geometry (central angle and radii of curvature) and plate potentials, is determined analytically and graphically. The method, which assumes that the ratio of plate spacing to mean radius is small, uses derived relationships between these parameters and the position of the center of the particle's trajectory, which trajectory is approximated by a circular arc. For a fine incident beam of particles angular resolution at mean transmitted energy and energy resolution at normal incidence are independent of the point of incidence; the angular resolution is moreover a constant and the energy resolution varies linearly with the mean energy. The area of energy-angle transmission diagrams is likewise independent of point of incidence. Energy and angle response functions for diffuse beams of particles are derived semiempirically. The energy response function (integrated over angle) has the same full width at half maximum (FWHM) as the function for a fine beam incident normally. The angle response function (integrated over energy) has the same FWHM as the function for a fine beam at appropriate fixed energy. Author

N67-31929# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

PORTABLE SOIL TEST DEVICES

Paul Spanski *In its* Soil-Vehicle Mech. Nov. 1966 p 242–253 refs (See N67-31921 18-11)

Described are design, construction, and operation of a portable, manually operated penetrometer and a portable, manually operated shear unit. The penetrometer is constructed of concentric sliding aluminum alloy tubing. Sinkage is measured by means of a 10-turn potentiometer, and components are arranged to allow a total axial movement of over 15 inches. The electric signals from the sensing units are fed to an X–Y plotter, thus giving a permanent visual record of a load-sinkage test. Within the limitation of the force available (a maximum of 480–500 lbs.) the device produces smooth load-sinkage plots, and it is only mildly sensitive to the operator's technique. The shear unit uses air pressure to obtain normal loading. Air pressure applied to the volume above the piston loads the shear annulus through a ball spline shaft and torque cell. The maximum travel of the piston-shear annulus is six inches. By varying the air pressure in the cylinder any desired normal load may be imposed on the shear annulus. Normal loads may be varied from 13 lbs. to 193 lbs., which corresponds to ground pressures of less than 1 psi to more than 9.5 psi. The supporting structure and the material are nearly identical to that used on the penetrometer. K.W.

N67-31931# Army Tank-Automotive Center, Warren, Mich. Land Locomotion Lab.

TERRAIN GEOMETRY MEASURING EQUIPMENT

L. A. Martin *In its* Soil–Vehicle Mech. Nov. 1966 p 272–278 (See N67-31921 18-11)

The profile measuring equipment and techniques discussed here are the result of a search for a fast, reliable system for measuring off-the-road profiles. The system uses the slope integration method of terrain geometry measurement. The theory of operation is based on two equations that require measurement of the slope angle of the ground and the distance traveled along the ground. The data reduction reconstructs the terrain profile by calculating horizontal and vertical distances for a known increment of distance traveled. A fifth wheel is used to indicate the distance traveled along the profile path. The wheel frame is free to rotate about its support point on the trailing arm, and a gyroscope mounted on the trailing arm establishes the horizontal datum. Data are recorded on a three channel tape recorder. Calibration and data reduction are briefly discussed. K.W.

N67-32044*# Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux (France).

EQUIPMENT FOR THE OBSERVATIONS OF METEOR TRAILS

J. Delcourt *In* NASA, Washington Meteor Orbits and Dust 1967 p 91–94 Sponsored by Centre Natl. d'Etudes Spatiales and IQSY (See N67-32038 18-30)

The characteristics of the angle-measuring system for radioelectrical observations and the measurements obtained with it are briefly described. The forward scatter path is 1000 km in the north–south direction, and the bistatic receiver and transmitter are 30 km apart in the east–west direction. The angle of arrival measurements and the Doppler measurement are discussed, along with the phase differences and areas of possible error. A sample meteoric echo record is presented. N.E.N.

N67-32100*# Rocketdyne, Canoga Park, Calif.

A NARROW FIELD-OF-VIEW, HIGH RADIANT HEAT FLUX SENSOR Final Report

P. E. Schumacher 10 Jan. 1967 45 p refs (Contract NAS8-11994)

(NASA-CR-86625; R-6741) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The fabrication and calibration of a prototype, radiant heat flux sensor is discussed. The heat flux sensors are high responsivity, short time constant radiometers, designed to operate reliably in the severe environs of rocket engine exhaust plumes. The sensors are designed to measure very high radiant emittance levels over a narrow field of view. Detailed drawings of the sensor and its components are presented. Author

N67-32107# Los Alamos Scientific Lab., N. Mex.

ELECTRONIC SCALE FOR MEASURING MASS FLOW

George N. Rupert 30 Mar. 1967 8 p refs (Contract W-7405-ENG-36)

(LA-3659) CFSTI: HC $3.00/MF $0.65

An electronic scale which measures small rates of mass flow ($\approx 1.5 \times 10^{-4}$ lb/sec) from a large gross weight (250 lb) is described. Four meters indicate the gross weight of the sample and

container, sample weight loss, rate of weight loss, and deviation of rate of weight loss from a preset desired rate. In operation, a semiconductor load cell senses the gross weight. The output of the load cell is amplified to produce an analog signal proportional to the gross weight. This signal is differentiated electronically to produce the rate of mass flow information in units of 0.1 lb/10 min. An additional output circuit shows the deviation of the rate of mass flow from a present desired rate. Author (NSA)

N67-32151* College of the Holy Cross, Worcester, Mass.
REPLICA GRATING STUDY Interim Report, Phase II, 1 Dec. 1966–1 Jul. 1967
Roy C. Gunter, Jr. 13 Jun. 1967 15 p
(Contract NGR-22-091-002)
(NASA-CR-86978) CFSTI: $3.00 CSCL 20F

The thermal-vacuum testing of samples of 1 meter concave replica diffraction gratings has been started. The first test, subjection of the gratings to pressures in the 10^{-9} torr range and at ambient temperature, has been completed. The gratings showed no significant change in line profile. Two plane gratings were subjected to pressures in the 10^{-13} torr range at ambient temperature and showed no significant change in their interferograms. Irradiation of a series of plane replica diffraction gratings 50 mm diameter by 10 mm thick and aluminized substrates of identical material (pyrex) and dimensions showed distortions of the interferograms starting at about 10^{12} electrons/cm^2. The distortion appeared to be the same in both replica gratings and aluminized substrate material leading to the tentative conclusion that at this energy level it is probable that the substrate material rather than the replication process would be the source of trouble. Author

N67-32303*# ITT Industrial Labs., Fort Wayne, Ind.
A DAY–NIGHT HIGH RESOLUTION INFRARED RADIOMETER EMPLOYING TWO-STAGE RADIANT COOLING Quarterly Report, 1 Oct. 1966–1 Jan. 1967
R. V. Annable, J. F. Lodder, D. J. Juarez, and R. A. Harber 15 Jan. 1967 44 p ref
(Contract NAS5-10113)
(NASA-CR-86913; ITTIL-67-1002; QR-3) CSCL 20F

This report covers the continuation of design and construction of a two-stage radiant cooler to be used in a 10.5 to 12.5 micron day–night high resolution infrared radiometer. It contains descriptions of the outer box and first-stage cone construction and the second-stage design. The design of test equipment for simulating cold space is outlined. The effects of patch thickness and altitude of operation on cooler geometry are studied, and the joule heating of the detector investigated. Additional optical design and initial electronic design are covered. Author

N67-32330*# Research Triangle Inst., Durham, N. C. Solid State Lab.
FEASIBILITY STUDY OF A MINIATURE SOLID-STATE PRESSURE TRANSDUCER Final Report
C. D. Parker Jul. 1967 84 p refs
(Contract NAS1-6249)
(NASA-CR-66428) CFSTI: HC $3.00/MF $0.65 CSCL 14B

The piezojunction effect as the sensory phenomenon in a miniature solid state pressure transducer is examined for possible application on meteorological sounding rockets and balloons. The piezojunction effect occurs at high stress levels in silicon and is characterized by an exponential increase in minority carrier density with increasing stress above the threshold stress level. Theoretical considerations of the piezojunction phenomenon are reviewed and two pressure transducer configurations are proposed. One is a simple diaphragm configuration in which the diaphragm material (silicon) is stressed directly by a pressure differential that balloons the diaphragm. This arrangement has many significant advantages derived from the absence of a physical contact to p–n junction area. The second configuration is the silicon needle sensor in which the stress-sensitive p–n junction is formed at the apex of a silicon needle. Its advantages are the absence of any alignment problems; the p–n junction area can be very small and the entire area readily stressed. Disadvantages associated with these two configurations are cited, and fabrication of the silicon needle sensors and pressure transducers are described. S.P.

N67-32332*# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
A CONTROL SYSTEM FOR X-RAY DIFFRACTOMETER SCANNING
L. H. Cook Jr. Aug. 1966 12 p refs
(Contract AT(07-2)-1)
(DP-900)

A time-based program controller using a prepunched tape was developed for automatic goniometer scanning of an X-ray diffractometer in which the locations of the diffraction lines are known. The program controller consists of a dual-speed drive unit which moves the goniometer rapidly over portions of the diffraction pattern not under observations and slowly over the diffraction lines to be observed, and an electronic control system which will scan the selected diffraction lines, print the accumulated data for each line, reset the goniometer, rewind the control tape, and then either stop or repeat the cycle. The control accuracy is within 0.01° Bragg 2θ angle. Author (TAB)

N67-32333*# Utah State Univ., Logan. Electro-Dynamics Labs.
A REAL TIME FOURIER TRANSFORM SYNTHESIZER
J. E. Hoffman, Jr. 1 Nov. 1966 132 p refs
(Contract AF 19(628)-3825; ARPA Order 450)
(AFCRL-67-0049; SR-7; AD-653200) CFSTI: HC $3.00/MF $0.65

A study of the relationship between the interferogram F(x) obtained in Fourier spectroscopy and the corresponding spectral distribution E is made. It is found that the spectral distribution is the Fourier cosine transform of the interferogram. Various computational techniques for performing the required transformation are studied, and a real time Fourier transform synthesizer is described. It has been designed to be compatible with a lamellar grating Michelson interferometer, but could be used just as well with a well-compensated Michelson interferometer. The system used to obtain the point of zero path difference is described in detail. A novel approach is used to obtain the cosine functions required in the synthesis of the cosine transform. All the computations except the summation are done in analog form, while the summation is done digitally. The result of the computation, the spectral distribution, is available as soon as the interferogram is obtained. Errors in the technique are discussed and methods of compensating for them are enumerated. TAB

N67-32402 Joint Publications Research Service, Washington, D. C.
NEW ELECTRONIC DIGITAL MEASURING DEVICES DESIGNED
V. Zelentsov 8 May 1967 10 p Transl. into ENGLISH from Nauchn-Tekhn. Obshchestva SSSR (Moscow), no. 1, Jan. 1967 p 54–57
(JPRS-40928; TT-67-31570)

Soviet advances in developing digital instruments are discussed, and the characteristics of several devices are described. These include a digital voltmeter for measuring dc voltages, a semiautomatic digital recorder, and an automatic ac bridge with a digital indicator. Summary information is also presented on the development of an electric drive for a ringless twister equipped with electric spindles, a resonance level gauge, prefabricated silos, and electronic strain gauge scales for automatically weighing railroad cars in motion. M.G.J.

N67-32468# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
DIGITAL RECORDING AND PLAYBACK EQUIPMENT (DRAPE)
Erno R. Bernheisel and Larry C. Queen Mar. 1967 147 p
(Contract NOw-62-0604-c)
(TG-897; AD-652817) CFSTI: HC $3.00/MF $0.65

The technical manual describes the Digital Recording and Playback Equipment (DRAPE) and provides information necessary for operating that equipment and maintaining it in an operable state. The DRAPE acquires both analog and digital data from multiple sources and converts them to serial PCM signals which are then recorded on magnetic tape. To ensure that it is operating correctly and that valid data are being acquired, DRAPE recovers the data immediately after they are recorded and converts them to analog signals. These signals may then be applied to a recording device for monitoring purposes. Prior to the acquisition of data, header information may be entered through switches on the front panel and recorded to aid identification. TAB

N67-32472*# Ohio Univ., Athens. Coll. of Engineering and Technology.
LEAK DETECTION TECHNIQUE IMPROVEMENT STUDY FOR SPACE VEHICLES Interim Report
Jan. 1967 308 p refs
(Contract NAS8-11199)
(NASA-CR-86670; IR-2-b) CSCL 14B

An extensive search of the literature published prior to 1962 on the subject of leak detection and related fields has been carried out. The information collected has been automatized by use of IBM cards and a computer so that information on any phase of this project can be readily available for use when needed. Author

N67-32488*# Ohio Univ., Athens. Coll. of Engineering and Technology.
LEAK DETECTION TECHNIQUE IMPROVEMENT STUDY FOR SPACE VEHICLES Annual Report
Jan. 1967 263 p refs
(Contract NAS8-11199)
(NASA-CR-86677; AR-2-a) CFSTI: HC $3.00/MF $0.65 CSCL 14B

A second generation model of the halogen gradient detector using the dual-flow principle is described herein. After a long and extensive study of the state-of-the-art in leak detection methods, accompanied by considerable experimentation with locally-generated concepts, the hot anode platinum diode modified by the dual-flow principle meets the specifications dictated by the application to missile leak detection best of all competitive concepts. Considerable space is therefore allocated to this method, and to a theoretical and experimental study of the platinum diode. The helium separation probe was designed, developed, and tested for use with the mass spectrometer. The superiority of a teflon membrane over heated silica glass for the given specifications is demonstrated. Author

N67-32487# HRB-Singer, Inc., State College, Pa.
SOME QUESTIONS RELATED TO THE MATHEMATICAL DESCRIPTION OF THE PHOTOGRAPHIC PROCESS
Erika A. Mares Apr. 1967 24 p refs
(Contract Nonr-2818(00))
(HRB-35216-R-3; AD-653083) CFSTI: HC $3.00/MF $0.65

The mathematical relationship between the points of two planes that have been mapped onto one another by the photographic process is investigated. The study is in essence expository and was motivated by a question concerning the ability to map one photographic image of a plane object onto a second image in such a way that corresponding points correspond to the same object or ground point. While in theory this is shown to be possible, provided certain conditions can be satisfied, any application would have to take into consideration the effect of errors contained in measured data. The error analysis is not pursued in this report. Author (TAB)

N67-32505# Stanford Univ., Calif. Stanford Electronics Labs.
SYSTEMS TECHNIQUES
In its Quart. Status Report., 1 Oct.–31 Dec. 1966 p 33–35 (See N67-32501 18-10)

Details are presented on the construction of a microwave refractometer for studying the tropospheric refractive-index structure and its effect on electromagnetic wave propagation. The refractometer consists of a sampling cavity, synchronous klystron locking system, and frequency measuring system. The characteristics of each of these are described. It is pointed out that the refractometer can detect refractive changes up to 300 N-units, although it is expected measurements will generally be on the order of 150 N-units. N.E.N.

N67-32508* Spacelabs, Inc., Van Nuys, Calif.
PROPELLANT LEAKAGE DETECTION SYSTEM Quarterly Progress Report No. 2, Mar. 1–May 30, 1967
30 May 1967 39 p
(Contract NAS9-6649)
(NASA-CR-65647) CSCL 21H

It is reported that major effort was directed to the mechanical design and evaluation of a three-probe heater sensor system, a preliminary investigation of a transient response system, and the selection of simulation fluids. Evaluation of a three-probe sensor system made of plexiglass to determine the relative change in the natural convection heat transfer coefficient led to the design and manufacture of an improved version made of stainless steel 304. The change in normalized average heat transfer coefficient and temperature change at the center of the heater sensor probes as a function of orientation are plotted, and detailed schematics of the electronic equipment are included. C.T.C.

N67-32559*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SLOW SPEED TACHOMETER FOR MEASURING WELD WIRE AND CARRIAGE FEEDS
H. E. Smith, J. R. Resquin, and C. Loyd 9 Jun. 1967 12 p
(NASA-TM-X-53615) CFSTI: HC $3.00/MF $0.65 CSCL 14B

Details are given on a tachometer system designed to measure the rate of weld wire feed and carriage feed to an accuracy of 0.0025 meter (0.1 in.) per minute. The system utilizes a visual display and an analog output for recording deviations in speed. Author

N67-32599*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CONVAIR 990 FLIGHT EXPERIMENT, SECTION VI
J. J. Webb *In its* Radiometry Progr. 1st Trimester, 1967 Apr. 1967 4 p (See N67-32594 18-23)

Troubleshooting and circuit modification efforts resulted in the normal operation of the Electronic Scanning Spectrometer (ESS), which had been out of commission for several months because of circuit board damage. Wavelength and intensity calibrations and refinements in the data acquisition technique for use aboard the Convair 990 aircraft are being made. A rotational platform to permit the ESS to track the sun by manual adjustment is being designed, and both design and fabrication of the entrance optics and the special support structure to mount the ESS in the flight configuration are underway. M.W.R.

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-31501*# Midwest Research Inst., Kansas City, Mo.
COLD MOLECULAR WELDING STUDY Final Report, Jun. 15, 1966–Jun. 14, 1967
C. Eugene Moeller and Michael Noland 14 Jun. 1967 15 p
(Contract NAS9-3623)
(NASA-CR-65661) CFSTI: HC$3.00/MF$0.65 CSCL 13H

Results of a program conducted to obtain a better understanding of experimental techniques for the evaluation of cold welding and to investigate the effects of certain test parameters not studied in the cold molecular welding study in ultrahigh vacuum are presented. The cold molecular welding characteristics of beryllium–copper pellets on 321 stainless steel wear plates were studied. The program consisted of four investigations: (a) the reproducibility of test results under identical experimental conditions; (b) a comparison between sliding tests in ultrahigh vacuum, dry air, and ambient air; (c) the effect of alternate sliding and resting of the metal couples for sliding durations between stops of one revolution and one-twelfth revolution; and (d) the effect of time at rest on the static coefficient of friction. Author

N67-31526*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND EXPERIMENTAL PERFORMANCE OF A SMALL CENTRIFUGAL PUMP FOR LIQUID HYDROGEN
George W. Lewis, Edward R. Tysl, and Melvin J. Hartmann Washington, NASA, Sep. 1960 29 p refs
(NASA-TM-X-388) CFSTI: HC $3.00/MF $0.65 CSCL 13K
(Declassified)

A radial-bladed 4-inch-diameter hydrogen centrifugal pump was designed and experimentally investigated. The design utilized a stream-filament solution (a method used in centrifugal compressors) which, through an iterative procedure, resulted in passage and blade shapes, number and position of blades, and calculated velocities throughout the pump rotor passage. The shrouded pump was operated at a flow coefficient of 0.20, a pressure coefficient of 0.585, and an indicated efficiency of about 0.65. An unshrouded version of this pump was tested, and reduced performance was observed. Author

N67-31535* Battelle Memorial Inst., Columbus, Ohio.
GAS-PRESSURE BONDING OF BERYLLIUM GYRO AND STABILIZED PLATFORM COMPONENTS Final Report, 1 Jan. 1966–31 May 1967
H. D. Hanes and P. J. Gripshover 31 May 1967 66 p
(Contract NAS8-11964)
(NASA-CR-86672) CSCL 13K

This study was conducted to prepare machining preforms of beryllium gyro and stabilized platform components by gas-pressure bonding, and to prove feasibility by final machining components from these preforms. The components which were prepared for the ST-124 gyro were: (1) stabilized platform gimbal, (2) sleeve, (3) air-bearing sleeve, (4) inner cylinder, and (5) inner cylinder cover. Author

N67-31548# Technische Hochschule Munchen (West Germany). Institut fuer Werkzeugmaschinen und Betriebswissenschaften.
EFFECT AND CONTROL OF CHATTER VIBRATION IN MACHINE TOOL PROCESSES Quarterly Technical Report, 1 Aug.–31 Oct. 1966
Klaus Corbach, Heinrich Dzaack, Hans Dirmeier, and Saripalle Satyamurty 30 Nov. 1966 37 p refs
(Contract AF 61(052)-961)
(QTR-2; AD-652494) CFSTI: HC$3.00/MF$0.65

In continuation of the efforts towards a general statistical evaluation of the available test data on several machine tools, eleven case reports concerning gear hobbing machines have been studied. The special characteristics of the gear hobbing process seem to allow a fairly simple specification for this class of machines. The improvements on the test rig for rotatory excitation of gear drives have been discussed and the design features and calibration characteristics of a new torque and displacement transducer are reported. Further description of circuitry and performance characteristics of some parts of the electronic apparatus devised for instantaneous measurement of transfer functions in general and cutting stiffness in particular are presented. TAB

N67-31560# Stanford Univ., Calif. Dept. of Materials Science.
SOME OBSERVATIONS OF THE STRENGTH OF SILVER BRAZED JOINTS IN DRILL ROD
Anton J. West, Jr. (M.S. Thesis) May 1967 55 p refs
(Grant NSF GK-1092)
(SU-DMS-67-5; TR-1)

The yield and fracture characteristics of drill rod brazed with 99.99% silver were studied as a function of base metal yield strength and joint thickness to diameter (t/D) ratio. Quantitatively it was found that for a constant thickness to diameter ratio both the macroscopic yield strength and fracture strength of the brazed joints increased as the base metal strength increased. In the temperature range from 20°C to −140°C the macroscopic yield of the brazed specimens was exactly the same as the yield strength of drill rod specimens without a joint. Triaxial strengthening of the brazed samples was observed even after yielding by the base metal, giving joint tensile strengths four to five times the unconstrained ultimate strength of silver. Specimens of constant base metal yield strength exhibited increasing fracture strength as t/D decreased, whereas the macroscopic yield strength remained constant equal to the yield strength of the drill rod. In all instances the overall strain at fracture for the brazed samples was drastically reduced compared to the fracture strain of the drill rod samples. Author

N67-31572*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
GAP WELDING PROCESSES AND APPLICATIONS
G. D. Adams *In its* Proc. of 2d NASA Microelectron. Symp. Jun. 1967 p 83–98 refs (See N67-31562 18-09)

The gap welding process has been studied, and procedures have been established to achieve maximum results. The process is shown to be dependent upon the control of materials and geometry. The application of gap welding to a wide range of electronic interconnection problems is described. The technique used in welding wires and ribbons ranging from 0.025 to 0.5 mm in size with a single welder is also described as is welding thin films, thick films, and printed wiring boards. A sample circuit utilizing a new design concept, planar gap welding, for component assembled circuits is shown, beginning with the electrical schematic to the finished circuit. Author

N67-31713# Pennsylvania State Univ., University Park. Dept. of Industrial Engineering.
SOURCES AND CONTROL OF MECHANICAL VIBRATIONS AFFECTING MACHINE TOOL PERFORMANCE QUALITY
A. O. Schmidt and Inyong Ham Rock Island, Ill., Rock Island Arsenal, Sep. 1966 119 p refs
(Contract DA-11-070-AMC-828(W))
(RIA-67-103; AD-653270) CFSTI: HC$3.00/MF$0.65

An investigation of the external and internal sources of vibration in machining operations which impair the performance quality of conventional machine tools was conducted as an extension

of the study made in Phase I (AD-625 103). Particular effort in this investigation was concentrated upon the effects of external vibration relative to the performance of machine tools: (a) environmental floor vibration under normal working conditions in the shop, (b) determination of the sensitivity of the cutter workpiece system to floor disturbance under various machine support conditions, (c) effect of floor vibrations on surface finish and accuracy, (d) vibration transmissibility characteristics from floor-to-machine and machine-to-floor under various machine support conditions. An isolated reaction mass of reinforced concrete was constructed and calibrated. A knee-type milling machine was placed on the platform using various types of isolators and varying shock impulses were applied by a shock machine on the platform. Separate tests on a cylindrical grinding machine were made to study the effect of wheel unbalance on the resulting surface characteristics. Further investigation on a drill press vibration was carried out to determine experimentally the dominant factors controlling vibration during drilling operations. Author (TAB)

N67-31726*# Indiana Univ., Bloomington. Aerospace Research Applications Center.
[EXPERIMENTS IN TECHNOLOGY UTILIZATION] Quarterly Report, Feb. 1–Apr. 30, 1967
30 Apr. 1967 38 p
(Contract NSR-15-003-055)
(NASA-CR-85577) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Development and implementation planning for marketing information technology covered programs on: standard interest profiles, evaluation of types of routes and service to the information warehouse, development of an analytical reference frame for identifying key questions, individual information processing during technical task solving, literature review for management information, search and identification of cities willing to participate in the program. G.G.

N67-31988*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTS WITH HYDRODYNAMIC JOURNAL BEARINGS OF VARIOUS MATERIALS AND DESIGNS IN SODIUM AT TEMPERATURES TO 800°F
Frederick T. Schuller, William J. Anderson, and Zolton Nemeth Washington, NASA, 1967 35 p refs To be presented at the Lubrication Conf., Chicago, 17–19 Oct. 1967 Revised
(NASA-TM-X-52247) CFSTI: HC $3.00/MF $0.65 CSCL 13I

Experiments were conducted with 1.5 inch diameter hydrodynamic journal bearings in liquid sodium at 500° and 800°F, speeds to 12,000 rpm and unit loads to 31 psi. The stability characteristics of four different geometries and the wear and seizure properties of several material combinations were investigated. Tilting pad bearings were most stable. Combinations of a cobalt alloy with nickel alloys or with a titanium carbide cermet showed the best wear and seizure properties. Author

N67-32031*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
DEFORMATION PROCESSING OF STAINLESS STEEL
D. E. Sorohacker (Battelle Mem. Inst.), A. F. Gerds, H. J. Henning, and F. W. Boulger 21 Oct. 1966 355 p refs Prepared by Battelle Mem. Inst., Columbus, Ohio.
(Contract (DA-01-021-AMC-11651(Z))
(NASA-TM-X-53569) CSCL 13H

Primary and secondary fabrication methods for stainless steel are discussed. Methods currently employed for primary fabrication of these alloys include: rolling, extrusion, forging, and drawing of tube, rod, and wire. Secondary metalworking operations are those processes that produce finished or semifinished parts of sheet, bar, or tubing using additional metalforming operations. The following secondary forming processes are discussed: brake bending, deep drawing, spinning, shear forming, drop hammer, trapped rubber, stretch forming, roll forming, dimpling, joggling, and sizing. Equipment and tooling used for the various operations are discussed and illustrated wherever possible. Author

N67-32193# Joint Publications Research Service, Washington, D. C.
THE RELIABILITY OF COMPLEX TECHNICAL SYSTEMS
29 Jun. 1967 354 p refs Transl. into ENGLISH of the book "O Nadezhnosti Slozhnykh Tekhnicheskikh Sistem" Moscow, "Sovetskoye Radio" Publishing House, 1966 p 1–324
(JPRS-41634; TT-67-32267)

In the anthology presented, basic postulates of the reliability theory are developed with respect to complex systems. Attention is also focused on the physics of failures and accelerated tests, and reliability test and evaluation techniques. For individual titles, see N67-32194 through N67-32213.

N67-32194# Joint Publications Research Service, Washington, D. C.
RELIABILITY, LONGEVITY, PRECISION
N. G. Bruyevich *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 5–25 refs (See N67-32193 18-15)

Early in the design state it is important to correctly determine the longevity of the future machine, on the basis of technical–economic considerations and the anticipated development of the corresponding branch of machine building and of the engineering sciences. The design of machine reliability from the standpoint of preservation of precision is no less important than from the standpoint of breakdown-free operation, since during operation loss of precision is more probable than breakdowns. The current theory of the precision of devices is useful in these calculations. Lastly, certain technical and economic-organizational measures are highly important to effective improvements in the reliability and longevity of machines. The term "machine" pertains to reliability, longevity and precision of not only machines but also instruments and devices unless otherwise specified. Author

N67-32195# Joint Publications Research Service, Washington, D. C.
FUNCTIONING EFFECTIVENESS OF COMPLEX SYSTEMS
I. A. Ushakov *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 26–54 refs (See N67-32193 18-15)

A method of evaluating the functioning effectiveness of complex systems of taking into account the reliability of their individual components is considered. Concepts of temporary-action and prolonged-action systems are presented and methods of evaluating their effectiveness described. A large number of typical system structures for which compact working formulas can be derived is presented. The exposition is illustrated with numerical examples. Author

N67-32196# Joint Publications Research Service, Washington, D. C.
CERTAIN LAWS OF THE TECHNICAL MAINTENANCE OF A MACHINERY POOL
I. A. Luyk *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 55–68 refs (See N67-32193 18-15)

The article deals with the effect of methods of utilization of the machinery pool on its effectiveness. Recommendations on selecting the capacity of repair facilities are provided. Author

N67-32197# Joint Publications Research Service, Washington, D. C.
PREDICTING THE RELIABILITY AND EFFECTIVENESS OF DYNAMIC SYSTEMS
B. V. Vasil'yev *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 69–89 refs (See N67-32193 18-15)

The article deals with the problems of predicting the reliability and effectiveness of systems with finite and nondenumerable sets of states. Principal attention is devoted to systems in which the random process is described by a complex "death" process. The utilization of the expansion of exact solutions of state probabilities into rapidly converging power series is proposed. Author

N67-32199# Joint Publications Research Service, Washington, D. C.

CERTAIN PROBLEMS OF THE RENEWAL THEORY AND FATIGUE RELIABILITY OF MECHANICAL COMPONENTS

V. F. Shukaylo *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 123–145 refs (See N67-32193 18-15)

Mathematical methods of reliability theory are applied to the problem of cumulative damage in mechanical components with emphasis on renewal probabilities. Several types of life distribution in fatigue tests and wear loads are described that show different positioning for the failure rate maximum. G.G.

N67-32200# Joint Publications Research Service, Washington, D. C.

SELECTING THE OPERATING MODE OF EQUIPMENT DURING TEMPORARY PAUSES IN OPERATION

Yu. G. Fokin *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 146–151 refs (See N67-32193 18-15)

Present-day findings indicate that during the first 10 minutes after the operation of equipment is started failures reach as much as 25 percent owing to the intense variation in electrical and thermal regimes. The article provides recommendations for selecting an expedient regime of equipment during temporary pauses. Author

N67-32201# Joint Publications Research Service, Washington, D. C.

CERTAIN OPTIMAL METHODS OF SEARCHING FOR DEFECTS IN ENGINEERING SYSTEMS

Yu. V. Lyubatov *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 153–171 refs (See N67-32193 18-15)

The article deals with the solution of the problem of diagnosing the defects of engineering systems. Certain new models of the process of locating defects in combinational and sequential searches are considered. Author

N67-32202# Joint Publications Research Service, Washington, D. C.

ON "CHANNEL" RELIABILITY

B. A. Kozlov *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 172–183 refs (See N67-32193 18-15)

A renewable redundant system of N components, n of which are operating components and N–n are used as standby components, is considered. The stationary reliability characteristics of some one of the n functioning components (subsystems) are estimated on condition that all redundant components may be used to replace any failed functioning component. Author

N67-32203# Joint Publications Research Service, Washington, D. C.

RELIABILITY CHARACTERISTICS OF AUTOMATED PREOPERATIONAL CHECKING

B. N. Volgin *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 184–192 (See N67-32193 18-15)

The article presents reliability criteria for preoperational checking of equipment, derives working formulas of reliability characteristics of checking and gives a qualitative analysis of the effect of type of monitoring panel failures on these characteristics. Author

N67-32205# Joint Publications Research Service, Washington, D. C.

ASYMPTOTIC METHOD OF ESTIMATING THE RELIABILITY OF COMPLEX SYSTEMS

I. N. Kovalenko *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 206–225 refs (See N67-32193 18-15)

The article clarifies the general conditions warranting an asymptotic evaluation of the reliability of complex repairable systems by means of the function of mean time between failures of components and the function of the distribution of renewal time. The author proposes for the investigation of highly reliable systems a method combining analytic calculations with statistical modeling. Author

N67-32206# Joint Publications Research Service, Washington, D. C.

ESTIMATING THE RELIABILITY OF COMPLEX ENGINEERING SYSTEMS IN THE PROCESS OF THEIR PRODUCTION

T. A. Golinkevich *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 226–235 *ref* (See N67-32193 18-15)

The specific features of complex systems are examined. Recommendations on estimating their reliability are presented on taking into account these features (in the stage of series production). Author

N67-32207# Joint Publications Research Service, Washington, D. C.

ESTIMATING THE RELIABILITY OF NONREDUNDANT AND REDUNDANT RENEWABLE EQUIPMENT WITH A LIMITED NUMBER OF RENEWALS

V. B. Gogolevskiy and V. P. Grabovetskiy *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 236–248 refs (See N67-32193 18-15)

The probabilities of correct functioning of nonredundant renewable equipment at an arbitrary time instant are determined for cases where this equipment has a limited number of spare parts and without their repair. The mean time and probability of failure-free operation are determined for redundant equipment on taking into account the number of spare parts. Author

N67-32208# Joint Publications Research Service, Washington, D. C.

ESTIMATION OF RELIABILITY BY METHODS OF STATISTICAL SIMULATION

S. A. Senetskiy and N. A. Shishonok *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 249–266 refs (See N67-32193 18-15)

Recommendations for the selection of most effective methods of using computer engineering to solve problems of the reliability of complex systems in the design stage are presented. Author

N67-32209# Joint Publications Research Service, Washington, D. C.

HOW PRELIMINARY INFORMATION IS TAKEN INTO ACCOUNT WHEN EVALUATING THE RELIABILITY OF COMPLEX SYSTEMS

V. I. Luk'yashchenko and A. N. Terpilovskiy *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 267–279 refs (See N67-32193 18-15)

The article deals with certain techniques of combining preliminary information with experimental findings when evaluating the reliability of complex engineering systems. It is shown that the consideration of preliminary information markedly enhances the accuracy of the reliability estimate when experimental findings are limited. Author

N67-32210# Joint Publications Research Service, Washington, D. C.

CONSTRUCTING THE LOWER CONFIDENCE BOUND FOR THE PROBABILITY OF FAILURE-FREE OPERATION OF A SYSTEM ACCORDING TO THE RESULTS OF TESTS OF ITS COMPONENTS

Yu. K. Belyayev *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 280–292 refs (See N67-32193 18-15)

A method of determining the lower confidence bound of the probability of failure-free operation of a system with redundancy is described. Author

N67-32212# Joint Publications Research Service, Washington, D. C.

ON THE RELIABILITY OF REDUCED TESTS

K. N. Tsvetayev *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 312–316 refs (See N67-32193 18-15)

The article examines the principles for substantiating the plan of reduced tests and concludes that supplier's and customer's risks depend on the type of the true distribution function. Findings on the estimated increase in the risks are presented for the case where the theoretical distribution is presumed to be exponential while the true distribution is a Weibull distribution with a form parameter other than unity. Author

N67-32213# Joint Publications Research Service, Washington, D. C.

ON THE CERTAINTY OF ACCELERATED TESTS OF COMPONENT RELIABILITY

A. I. Perrote *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 317–328 refs (See N67-32193 18-15)

The article deals with the effect of the certainty of preliminary tests on the fidelity of the reliability estimate based on the method of accelerated tests. Two cases are considered: the case where the functional relationship between reliability parameters in various regimes is unknown, and the case where the type of this relationship is specified. Author

N67-32319# Mechanical Technology, Inc., Latham, N. Y.

A NUMERICAL SOLUTION OF THE ELASTOHYDRODYNAMIC FILM THICKNESS IN AN ELLIPTICAL CONTACT ELLIPTICAL CONTACT

Herbert S. Cheng May 1967 37 p refs

(Contract N00014-66-C0037)

(MTI-67-TR25; AD-652923) CFSTI: HC $3.00/MF $0.65

A numerical solution of the elastohydrodynamic film thickness in an elliptical contact is developed. The three dimensional Reynolds equation in the inlet region is solved by a finite difference method. The deformation contour in the inlet region is calculated according to the classical Hertz theory for elliptical contacts. Results are presented as side leakage film reduction factors, which are defined as the ratios of the film thickness of the finite contact to that calculated by a line contact theory based on the same maximum Hertz stress. The results obtained for b/a approaches infinity, which corresponds to a line contact, and for b/a = 1, which corresponds to a circular contact, agree with others. Comparison with experimental data indicates that the theory in the report predicts a film thickness slightly higher than those measured by the experiment. Author (TAB)

N67-32378* Advanced Kinetics, Inc., Costa Mesa, Calif.

DESIGN, DEVELOPMENT AND MANUFACTURE OF IMPROVED MAGNETOMOTIVE FORMING TOOLS Final Technical Report

19 May 1967 209 p refs

(Contract NAS8-19008)

(NASA-CR-86579) CSCL 09C

Studies were conducted to determine the pertinent electromagnetic parameters of the magnetic hammer—workpiece system for the purpose of applying these low inductance configurations to the Saturn V fabrication. Of particular interest were hammers for correcting deformations encountered in linear welds around the vehicle. The emphasis during the studies was on calculations of currents and fields for two-dimensional configurations, the field and force profiles for specified loads, and the problem of current optimization. Results are presented of experiments with prototype dipole hammer systems and a prototype ring hammer. Tests of NASA magnetic forming devices involved the ring hammer, the dipole ridge hammer, and the magnetic flaring tool. The experimental data that were obtained indicate the importance of accurate dimensioning of the conductor geometry. The theoretical and experimental results can be combined to formulate guidelines for the scaling of current and voltage requirements as a function of hammer size. K.W.

N67-32604*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

QUALITY ASSURANCE LABORATORY, APPENDIX III

In its Radiometry Progr. 1st Trimester, 1967 Apr. 1967 3 p (See N67-32594 18-23)

A room with controlled temperature of 40° to 50°F will be established for storing uncatalyzed samples of paints used for satellites or their components. It is recommended that flat 5/16"-diameter substrates simulating objects to be sprayed be prepared for future reference and testing, and retained in another area for future reference and testing; and that this library area include vapor deposited specimens representative of actual objects. M.W.R.

N67-32641# Frankford Arsenal, Philadelphia, Pa. Fire Control Development and Engineering Labs.

MICROWAVE TECHNIQUES AS APPLIED TO NONDESTRUCTIVE TESTING OF NONMETALLIC MATERIALS Test Report

Theresa M. Lavelle, Joseph T. Lehman, and Don Latshaw Mar. 1967 42 p refs

(FA-T67-9-1; AD-652268) CFSTI: HC $3.00/MF $0.65

Microwave techniques utilizing basic transmission, reflection and scattering phenomena were developed for a nondestructive testing program at two frequencies, 9.6 GHz and 35 GHz. The test specimens used include epon 828 and 815 resin samples, retread rubber tire, fiberglass tubes and pitted metal plates. The results obtained indicate that the techniques are useful for the measurement of thickness and for the detection of flaws, lack of bond, and degree of cure for geometrically smooth, homogenious samples. A 15 cm thick epoxy resin sample was measured to an accuracy of plus or minus 0.1 mm at 9.6 GHz. The present laboratory setup however, is not capable of detecting small defects in complex, nonhomogeneous samples. Resolution of such defects is limited by the irregularities of the sample surface, the difficulty of focusing the antenna beam and the abrupt or random change in material composition. Author (TAB)

N67-32647# Naval Ordnance Test Station, China Lake, Calif.

SPARK CUTTER FOR LABORATORY USE

C. W. Fountain May 1967 34 p refs

(NOTS-TP-4324; AD-652388) CFSTI: HC $3.00/MF $0.65

A spark cutter of the relaxation circuit type is described that can be used to produce tensile test specimens, electron microscopy specimens, specimens for grain-size and microhardness tests, and rods and discs for other metallurgical or metallographic purposes. A rotating specimen and a rotating cutting tool on carriages that move perpendicular to each other allow specimens up to 5 cm in diameter and up to 32 cm in length to be worked. Author (TAB)

N67-32679 Materials Research Lab., Inc., Richton Park, Ill.
WARM WORKING OF ARMOR PLATE Final Technical Report
R. P. O'Shea, N. N. Breyer, and E. Ripling 15 Mar. 1967 140 p refs
(Contract DA-11-022-AMC-1879(W))
(MRL-508-F1; AD-652079) CFSTI: HC $3.00/MF $0.65

Taking advantage of warm working to improve the toughness of armor plate requires that the plates be able to be rolled on present day mills. Calculations indicated that a 60 inch wide steel plate with hardnesses in excess of 400 BHN could not be rolled the required 20 percent in a single pass on existing mills. The plate could be reduced this amount in a multi-pass operation, however. A study of mechanical properties of worked steel showed that armor produced by this technique would be highly anisotropic. Although most studies on strain tempering indicate that the properties of steel are significantly improved by this process, such improvements are not found in the direction of compressive strains. Consequently the processing does not appear promising for armor plate which requires a high level of toughness in all directions. On the other hand, it may be possible to produce dual hardness armor without an interface between the hard and soft layers by means of redundant mechanical working. Author (TAB)

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-31658*# Hughes Research Labs., Malibu, Calif.
INVESTIGATION OF THE POTENTIALITIES OF PHOTOCHEMICAL LASER SYSTEMS. PART I: SURVEY AND ANALYSIS Final Report, 1 Feb. 1966–31 Jan. 1967
C. R. Giuliano, L. D. Hess, and J. D. Margerum 31 Jan. 1967 152 p refs
(Contract NAS12-94)
(NASA-CR-85005) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Photodissociative laser systems are proposed and evaluated with regard to their potential for conversion of solar radiation to monochromatic coherent emission. Spectroscopic and photochemical properties of several molecules which absorb light in the visible and near ultraviolet regions are reported, discussed, and compared with requirements for obtaining laser action. Additional mechanisms for achieving population inversions in these systems indirectly, such as Franck–Condon pumping and association processes stabilized by stimulated emission, are also discussed. Preliminary experimental studies are reported for methyl iodide and bromide, iodo- and bromocyanogen, iodine bromide, and nitrogen dioxide. Laser action was observed under a variety of experimental conditions from CF_3I and NOCl, but could not be detected in the initial studies conducted with other compounds. Chemical reversibility was demonstrated for the nitrosyl chloride system using mixtures of molecular chlorine and nitrosyl chloride. Author

N67-31675# Library of Congress, Washington, D. C. Aerospace Technology Div.
FIBER-OPTICS LASER WITH NONRESONANT FEEDBACK
Yuri Kaander *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 52–57 refs (See N67-31672 18-34)

Preliminary results of the first Soviet experimental glass fiber laser with nonresonant feedback are presented. The device, which consists of a bundle of thin unpolished Nd^{3+}-doped glass fibers, emits monochromatic, coherent radiation at $\lambda = 0.06\ \mu$. Author

N67-31680# Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
MAGNETO-OPTICAL OBSERVATIONS WITH PULSED ARGON LASER LIGHT
John L. Tomlinson *In its* Foundational Res. Proj. 15 Mar. 1967 p 1–3 refs (See N67-31679 18-26)

Magnetic domain patterns 1 cm^2 were observed photographically on a FeCoNi film by means of illumination from a pulsed argon laser. Although uneven illumination resulted in less contrast than is desirable, the process offers the possibility of being used for high speed magneto-optical observations. Author

N67-31738*# Rochester Univ., N. Y. Dept. of Electrical Engineering.
STUDY OF CW GASEOUS LASERS FOR SPACE COMMUNICATIONS Semiannual Status Report, 1 Jul.–30 Nov. 1966
Hideya Gamo and Toshiharu Tako 1 Dec. 1966 13 p
(Grant NGR-33-019-048)
(NASA-CR-83577; SASR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20E

The development of a CW gaseous laser which has potentialities for space communications. The He–Xe 3.5 micron gaseous laser was chosen since its line falls in one of the best atmospheric windows, and its gain is the highest known to date, 4 db/cm, although its output power is not very high. Excellent frequency stabilized Xenon laser is expected from the facts that the Doppler line width is narrow and the laser can oscillate in the low pressure where the pressure broadening is negligibly small. By applying the laser amplifier to the output of a frequency stabilized Xenon laser, a relatively high power laser beam is obtained. Author

N67-32022# Cornell Univ., Ithaca, N. Y. School of Electrical Engineering.
CHARACTERISTICS OF THE STOKES EMISSION IN THE STIMULATED BRILLOUIN SCATTERING PROCESS Interim Scientific Report
C. L. Lang 30 Oct. 1966 61 p refs
(Contract AF 19(628)-5677)
(AFCRL-67-0051; SR-1; AD-653210) CFSTI: HC $3.00/MF $0.65

The characteristics of the Stokes emission in the stimulated Brillouin scattering of intense laser light in non-focusing media were studied in detail both theoretically and experimentally. Simple formulas that describe the various characteristics of the Stokes emission are obtained for the case when the attenuation length of the microwave phonons involved is much shorter than the interaction length and the distance over which the Stokes intensity in the medium changes appreciably due to the stimulated Brillouin process. This condition is generally fulfilled in most room-temperature experimental situations; these results can, therefore, be used as a convenient basis for interpreting the experimental results. Stimulated Brillouin scattering of collimated ruby laser beams in such non-focusing liquids as n-hexane, methanol, and carbon tetrachloride was investigated. It was found that the experimental data obtained is in very good agreement with the calculated results obtained on the basis of the simple steady state theory given. Author (TAB)

N67-32128# Army Environmental Hygiene Agency, Edgewood Arsenal, Md.
LASER HAZARDS BIBLIOGRAPHY
David H. Sliney and William Palmisano Apr. 1967 26 p refs
(AD-652707) CFSTI: HC $3.00/MF $0.65

The bibliography provides a source of references for those interested in the biological effects and the evaluation of hazards associated with laser equipment. The references are categorized into six principal sections: General Information; Biological Effects -

General Research; Skin Effects; Eye Effects; Safety and Protective Equipment and Procedures; and Atmospheric Attenuation of Laser Beams. TAB

N67-32190# Stanford Univ., Calif. Microwave Lab.
OPTICAL MASER RESEARCH
A. L. Schawlow, R. M. Macfarlane, and S. Johnson *In its* Microwave Res. Nov. 1966 9 p refs (See N67-32189 18-10)

Research designed to improve and extend the performance of optical masers so that they can be used for physical research problems is reported. Focused on are studies of the causes of spectral linewidth which were undertaken in an effort to discover favorable materials with unusually narrow lines. Studies of the temperature dependence of linewidths and positions in $LaF_3:Nd^{3+}$; and theoretical studies of the effects of stress on spectra of ions in crystals; are summarized. S.C.W.

N67-32277* Wisconsin Univ., Madison. Dept. of Mechanical Engineering.
FLUORESCENT PHOTOGRAPHY OF DROPLETS IN A SPRAY USING A Q-SWITCHED LASER AS A LIGHT SOURCE
John Groeneweg (NASA Lewis Labs.), Hiroyuki Hiroyasu (Toyota C. R. D. Lab., Japan), and Richard Sowls 1 Jul. 1967 26 p refs
(Contract NsG-601)
(NASA-CR-72251) CFSTI: $3.00 CSCL 20E

A method of spray photography is described which utilizes a Q-switched laser light source to excite a fluorescent dye in the liquid being sprayed. In order to obtain a laser wavelength falling within the dye's absorption band, the second harmonic of ruby at 3471Å was generated using a KDP crystal. The workability of the method was demonstrated by taking spray photographs of droplets as small as 10 μ. The types of image fine structure observed are illustrated and discussed. A dynamic size calibration showed that reliable drop size information could be obtained from the spray photographs. Author

N67-32556# Perkin-Elmer Corp., Norwalk, Conn. Electro-Optical Div.
STUDY—FAR INFRARED GENERATOR Final Report, 1 Dec. 1965–30 Apr. 1967
Fritz Zernike 30 Apr. 1967 26 p refs
(Contract Nonr-4680(00))
(PE-TR-8779; AD-652830) CFSTI: HC $3.00/MF $0.65

A description is given of studies aimed at producing a far infrared generator by mixing two laser generated frequencies. Attempts to use two CO2 CW operating lasers proved unsatisfactory. A successful experiment was performed, however, by using a single Q-switched CO2 laser simultaneously radiating at 9.6 and 10.6 microns and focused on an InSb crystal. TAB

N67-32638# Ballistic Research Labs., Aberdeen Proving Ground, Md.
LASER IMPULSE MEASUREMENTS WITH ELECTRONIC DETECTION SYSTEM
Milan D. Stoller Apr. 1967 16 p ref
(BRL-TN-1651; AD-653139) CFSTI: HC $3.00/MF $0.65

An electronic device to determine the swing of a ballistic pendulum when the pendulum is struck by laser radiation is described and its operation analyzed. Author (TAB)

N67-32690# American Optical Co., Southbridge, Mass.
OPTICAL INHOMOGENEITIES IN PUMPED LASERS, VOLUME I Final Report, 1 May 1966–31 Oct. 1966
Charles J. Koester May 1967 108 p refs
(Contract Nonr-4875(00); ARPA Order 306; Proj. Defender)
(RD-701-580, Vol. I; AD-653069) CFSTI: HC $3.00/MF $0.65

The report delineates efforts expended on a project which required an analysis in depth of thermal distortion of wavefronts in large laser rods and discs. Two approaches for elimination of this distortion were considered: (1) establishment of a uniform temperature throughout the laser during pumping and (2) development of athermal glass parameters. Elements of both approaches were found necessary to solve the problem. In separate sections of the report detailed treatments are given to thermally stable cavities, temperature profile calculations, the effect of the laser field on index of refraction of the laser rod, and finally an analysis of end region stress. Author (TAB)

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-31625*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STRUCTURAL CONCEPTS AND MATERIALS SELECTION IN THE FEASIBILITY STUDIES
Richard A. Pride *In its* Proc. of NASA Conf. on Supersonic-Transport feasibility studies and Supporting Res. Dec. 1963 p 333–347 refs (See N67-31606 18-02)

Feasibility studies of the four SCAT configurations by two contractors show that 8Al–1Mo–1V duplex-annealed titanium alloy is the most efficient material for use in the primary structure. Skin-stringer type of construction was utilized on both wing and fuselage designs. Calculated thermal stresses were shown to result in an overall increase in structural weight of less than 2 percent, even though different methods were used to combine thermal stress with load stress for ultimate load conditions. Structural weights were 25 to 29 percent of the gross weight on all except a variable-sweep dual-wing configuration, which had a structural weight that was 37 percent of the gross weight. Author

N67-31626*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
NASA RESEARCH ON MATERIALS APPLICABLE TO SUPERSONIC TRANSPORTS
Herbert F. Hardrath and George J. Heimerl *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 349–362 ref (See N67-31606 18-02)

On the basis of studies on fatigue behavior, rate of fatigue crack propagation, residual static strength, and resistance to deterioration of properties due to prolonged exposure to temperature, no serious materials problems are anticipated. However, stress corrosion is found to be a potentially serious problem in titanium alloys in a hot salt environment and in stainless steels in an ambient environment. The Ti-8A1-1Mo–IV alloy is found to be generally superior to other contending materials in all respects studied except for salt stress corrosion in which respect it was poorer than all others. Author

N67-31718# Brookhaven National Lab., Upton, N. Y.
MONEL AND NICKEL CORROSION IN NONAQUEOUS NO_2–HF SOLUTIONS

Akiichi Kigoshi and Gerald Strickland Aug. 1966 12 p refs
(Contract AT(30-2)-GEN-16)
(BNL-50007) CFSTI: HC$3.00/MF$0.65

The corrosion rates of Monel alloy 400 and Nickel 200 were studied in several NO_2–HF solutions that seem promising for use in reprocessing nuclear reactor fuels. Special probes fabricated of Monel or Ni wire were immersed in solutions containing up to 30 mole % NO_2 and heated in the range 25 to 150°C. The progress of surface corrosion was followed by measuring the change in electrical resistance of the wire probes. In general, Ni was superior to Monel. Increasing concentrations of NO_2 were used, and the first detectable corrosion of Monel occurred in 20 mole % NO_2–80 mole % HF solution at 150°C. For Ni the conditions were 25 mole % NO_2 and 125°C. In solutions containing 25 and 30 mole % NO_2 the high initial corrosion rate of Monel gradually decreased to a very low value because of formation of a protective film. This film was strong enough to endure large changes in concentration or temperature. Moisture had a severe effect on vapor phase corrosion of both Monel and Ni. Dissolved UO_2 or the presence of H_2O increased corrosion in the liquid phase. The effect of stress on surface corrosion was insignificant in the elastic range, but in the plastic range it greatly increased both the initial corrosion rate and total corrosion during film formation. It was concluded that both Monel and Ni are satisfactory materials of construction. Author (NSA)

N67-31801# Bureau of Mines, Berkeley, Calif.
THERMODYNAMIC PROPERTIES OF FORSTERITE AND SERPENTINE
E. G. King, R. Barany, W. W. Weller, and L. B. Pankratz Jun. 1967 24 p refs
(BM-RI-6962)

The Bureau of Mines made experimental determinations of the heats of formation of forsterite and chrysotile at 298.15°K. The heat capacities of two polymorphs of serpentine, chrysotile and antigorite, were measured over the temperature range from 50° to 298°K and the entropies at 298.15°K were evaluated. The heat content of antigorite above 298.15°K was measured to 950°K. These thermochemical data were combined with other pertinent data to give heat and free energy of formation values at high temperatures. Free energy values are given for the reaction, forsterite + water = brucite + serpentine at different temperatures and pressures. Author

N67-31847*# Toronto Univ. (Ontario).
AN ATTEMPT TO CORRELATE BIMODAL FATIGUE ENDURANCE DISTRIBUTIONS IN OFHC COPPER WITH WOOD'S H, F, AND E RANGES
D. B. Muggeridge Jun. 1967 46 p refs
(Grant NGR-52-026-008)
(NASA-CR-66425; UTIAS-TN-111) CSCL 11F

The results of a metallographic study of a sampling of annealed and then fine machined OFHC copper specimens from statistically meaningful samples, fatigued under constant amplitude tension–compression are presented. An attempt was made to correlate their microstructure with that characteristic of W. A. Wood's H, and F amplitude ranges of the generalized S–N curve. The sampling specimens for the microstructural examination were taken from the tail ends of the endurance distributions at each of four stress levels around the lower knee of the S–N curve. The microstructural evidence and data from appropriate mechanical tests show that the fatigue mechanisms responsible for failure are H and F. Transition from H to F with decreasing stress level demonstrates the co-existence of the H and F fatigue mechanisms and suggests a bimodal distribution of endurances. For comparative purposes, a small group of re-annealed electropolished specimens was also examined. Observations on crack tip profiles support Laird's work on the plastic relaxation process in crack propagation. Author

N67-31877 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE PROPERTIES OF STAINLESS STEEL 1H18N9T AFTER AGING IN THE POWER REACTOR TEMPERATURE RANGES. PART I. MECHANICAL PROPERTIES
F. Seyna and M. Chyczewski 1966 25 p In POLISH; ENGLISH summary
(INR-770/XIV/PS)

The influence of time and aging temperature on the mechanical properties of stainless steel initially water quenched from 1150°C and cold-rolled with different per cent reduction was investigated. No significant change was found in the temperature range 300° and 400°C, but very important changes were noticed at temperatures 500°C and 600°C. The mechanical property changes depends on the degree of deformation. Author

N67-31899# Joint Publications Research Service, Washington, D. C.
REDUCTION OF CALCIUM OXIDE WITH FERROSILICON IN A VACUUM ALONG WITH THE FORMATION OF MOLTEN SLAG
A. S. Mikulinskiy and V. A. Kozlov *In its* Processes and App. of Vacuum Electrothermy 23 Jun. 1967 p 41–54 refs (See N67-31894 18-06)

Experiments are reported which were carried in the ore-thermic furnace to determine the conditions of calcium oxide reduction yielding molten slags as by-products instead of solid residue. The principal aims of the experiments were to select the right charge composition for producing calcium along with the molten slags, and to determine the temperature of the onset of reduction, the rate of reduction, and the ratio between the rates of reduction of CaO by silicon and aluminum. Details are given on the procedures and the methods of measurements, and extensive data are tabulated. It was concluded that: (1) Silicothermic reduction of calcium oxide with the formation of molten slag is sufficiently complete at 1650°–1700°C, 1–2 mm Hg pressure, and one hour duration. (2) Graphite must be used as the furnace lining. (3) The chief impurities are CaO and C and may be removed from the condensate by distillation. N.E.N.

N67-31919*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
SUMMARY OF THERMOPHYSICAL PROPERTIES OF POTASSIUM
Harold H. Coe Washington, NASA, Dec. 1966 40 p refs
(NASA-TN-D-3120) CFSTI: HC$3.00/MF$0.65 CSCL 07B

Recently reported thermodynamic and physical property data on the alkali metal potassium are compiled and the results of the various sources are compared with previously existing data. Data for the liquid properties of specific heat, thermal conductivity, enthalpy, entropy, viscosity, electrical resistivity, density, and surface tension are presented over the temperature range from 200° to 2200°F when possible. Data for the saturated vapor properties of specific heat, thermal conductivity, vapor pressure, heat of vaporization, entropy of vaporization, viscosity, and density are presented over the temperature range from 800° to 2200°F. The results from the several sources agree very well for most of the properties in the lower temperature range up to about 1400°F. However, significant differences are apparent for some of the properties at temperatures above 1400°F. Author

N67-32188*# General Technologies Corp., Alexandria, Va.
DEVELOPMENT OF DISPERSION STRENGTHENED CHROMIUM ALLOYS Summary Report
E. F. Abrams, J. A. Alexander, R. G. Shaver, and J. C. Wilson 15 Mar. 1967 42 p refs
(Contract NAS3-7606)
(NASA-CR-54810) CFSTI: HC$3.00/MF$0.65 CSCL 11F

The preparation of dispersion strengthened chromium having minimal quantities of interstitial impurities was investigated using aqueous and fused salt electrodeposition techniques. With the aqueous bath, nitrogen interstitial contents of less than 5ppm were obtained in "as deposited" chromium and oxygen interstitial contents were reduced to 30 ppm by heat treatment with ultrapure hydrogen. Promising microstructures were obtained with the aqueous electrodeposition approach, but were not reproducible. The main problem in preparing dipersion strengthened chromium by this technique was found to be the inclusion of insufficient quantities of alumina or thoria dispersoid. No usable electrodeposits were made with the fused salt bath techniques studied. Author

N67-32173# Argentina. Comision Nacional de Energia Atomica, Buenos Aires. Dept. de Metalurgia.
RELATIONSHIP BETWEEN SEGREGATION SUBSTRUCTURES AND CASTING STRUCTURES Annual Report
H. Biloni, R. Di Bella, R. Morando, and F. J. Kiss Mar. 1967 68 p refs
(Contract DA-ARO-49-092-66-6105)
(AD-652288) CFSTI: HC $3.00/MF $0.65

Evidence is presented relating to the impossibility of micropore formation in the cellular substructure by a microshrinkage mechanism. A study is made of the detailed relationship between solidification substructure and microsegregation in dilute tin alloys. A method of investigating the instability of interfaces when Constitutional Supercooling exists in ternary alloys is developed. Interaction among the solutes under non-ideality conditions is considered. A cold microscope stage is developed for the study of predendritic growth in organic compounds such as ciclohexanol and carbon tetrabromide. The effect of scale up the ingots size on structure and substructure is studied. Three sets of ingots of approximately 50 cc., 500 cc. and 5000 cc., is investigated. TAB

N67-32192# Israel Inst. of Tech., Haifa. Material Mechanics Lab.
THE MECHANICS OF REPEATED DISCONTINUOUS YIELDING OF METALS
S. R. Bodner Mar. 1967 50 p refs
(Contract AF 61(052)-951)
(MML-6; SR-4; AD-652240) CFSTI: HC $3.00/MF $0.65

An explanation is proposed for the occurrence of repeated discontinuous yielding of metals. The discussion is based primarily on observations for slightly impure aluminum, but is sufficiently general to apply to most metals. The responsible material property is considered to be time dependent strengthening that takes place during yielding. The details of the discontinuities, i.e. whether steps or serrations appear on the stress-strain relation, are shown to depend on the mechanics of the test procedure. The dislocation processes involved in repeated discontinuous yielding are described in terms of the equations of dislocation dynamics. The hypothesis of successive breakaway of dislocations from pinning points appears to be unnecessary in explaining this effect. Author (TAB)

N67-32296 Joint Publications Research Service, Washington, D. C.
HIGH TEMPERATURE COATING OF METALS
17 May 1967 29 p refs Transl. into ENGLISH from the book "Vysokotemperaturnyye Pokrytiya" Moscow, 1967 p 44–46, 110–114, 145–153
(JPRS-41067; TT-67-31708) CFSTI: $3.00

CONTENTS:

1. SOLID PHASE FORMATION UPON A SPHERICAL SURFACE S. A. Klevtsur, T. Kh. Sedel'nikov, N. S. Gorbunov, N. N. Repnikov, P. G. Tsyba et al p 1–7 (See N67-32297 18-17)

2. COATINGS OF MOLYBDENUM SILICIDES ON GRAPHITE G. V. Zemskov, A. S. Sin'kovskiy, and L. K. Gushchin p 8–13 (See N67-32298 18-17)

3. COATINGS ON HIGH-MELTING COMPOUNDS ON GRAPHITE A. L Burykina and T. M. Yevtushok p 14–23 refs (See N67-32299 18-17)

N67-32297# Joint Publications Research Service, Washington, D. C.
SOLID PHASE FORMATION UPON A SPHERICAL SURFACE
S. A. Klevtsur, T. Kh. Sedel'nikov, N. S. Gorbunov, N. N. Repnikov, P. G. Tsyba et al *In its* High Temp. Coating of Metals 17 May 1967 p 1–7 (See N67-32296 18-17)

A study was conducted to determine the mechanism involved in the deposition of zirconium nitride on a small graphite sphere. The experimental equipment and procedures used are described. A theoretical analysis of the process was also made based on the two-stage theory. The theoretical results closely approximated the experimental data. This supports the conclusion that the mechanism of deposition of a zirconium nitride coating can be adequately described in terms of the two-stage theory. R.N.A.

N67-32298# Joint Publications Research Service, Washington, D. C.
COATINGS OF MOLYBDENUM SILICIDES ON GRAPHITE
G. V. Zemskov, A. S. Sin'kovskiy, and L. K. Gushchin *In its* High Temp. Coating of Metals 17 May 1967 p 8–13 (See N67-32296 18-17)

A process is described for depositing a protective coating from the gaseous phase on graphite. The coating is applied by depositing molybdenum from a molybdenum halide on graphite heated by a high frequency gas discharge. This is followed by a siliconization of the coating from a gaseous phase of silicon tetrachloride. This procedure makes it possible to accelerate the deposition of uniform coatings. The concentration of silicon tetrachloride in the gaseous mixture and the temperature of the process exert an influence on the phase composition and growth rate of the diffusion layer. R.N.A.

N67-32299# Joint Publications Research Service, Washington, D. C.
COATINGS OF HIGH-MELTING COMPOUNDS ON GRAPHITE
A. L. Burykina and T. M. Yevtushok *In its* High Temp. Coating of Metals 17 May 1967 p 14–23 refs (See N67-32296 18-17)

Results are reported on the development of techniques for and the conditions pertaining to the formation of graphite coatings consisting of the carbides of titanium, zirconium, and niobium, and also of aluminum nitride. The carbide deposition process is comprised of two consecutive stages: the deposition of a metallic layer from a liquid phase in vacuum, and a diffusional annealing–carbidizing of the metallic layer. The aluminum nitride coating produced by plasma spraying of aluminum followed by a nitridizing of the metal layer. R.N.A.

N67-32398*# Battelle Memorial Inst., Columbus, Ohio.
A STUDY OF HYDROGEN EMBRITTLEMENT OF VARIOUS ALLOYS Annual Summary Report, 24 Jun. 1966–23 Jun. 1967
T. P. Groeneveld, E. E. Fletcher, and A. R. Elsea 23 Jun. 1967 83 p refs
(Contract NAS8-20028)
(NASA-CR-86675) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Hydrogen embrittling tendencies of selected cleaning, pickling, and electroplating processes reported to be nonhydrogen embrittling were studied, and the effectiveness of commonly used

hydrogen-embrittlement relief treatments were evaluated. An AISI Type 410 stainless steel was found to be susceptible to hydrogen-stress cracking when cathodically charged with hydrogen under high applied tensile stresses, but not after electroplating with a Wood's-nickel strike that was not cathodically charged. A Ti–6Al–4V alloy was not susceptible to hydrogen stress cracking failures during pickling in a number of solutions. Hydrogen analyses indicated that some hydrogen was usually released from nickel, cadmium, and chromium specimens subjected to baking treatments, and that the type of electroplate influenced the amount of hydrogen removed. Only nickel and chromium electroplates contained measurable residual stresses, and these were 1500 psi tensile and 38,000 psi tensile, respectively. M.W.R.

N67-32475# Bureau of Mines, Rolla, Mo.
TESTS FOR TIN–LEAD SOLDERS AND SOLDERJOINTS
V. R. Miller, A. E. Schwaneke, and J. W. Jensen Jun. 1967 32 p refs
(BM-RI-6963)

Methods for testing the tensile and shear strength of cast specimens of bulk solder and of solderad joints in order to increase the strength and extend the useful temperature range of soft solders were investigated. A spread-area test for determining the wettability of solder on copper surfaces was developed. Mannitol was used as a flux in spread tests to control spreading and to avoid plating, etching, and other side effects of regular fluxes. Data on commercial and high-purity solders obtained by these methods show more consistency than those reported by others from similar tests. Author

N67-32520* Applied Magnetics, Santa Barbara, Calif.
[THE DEVELOPMENT AND THE RESULTS OF A SPUTTERING PROCEDURE FOR ALFESIL-YIELDING THIN MAGNETIC COATING MATERIALS] Final Report
[1967] 25 p
(Contract NAS5-10117)
(NASA-CR-86994) CSCL 11F

This report describes fully the development and the results of a sputtering procedure for Alfesil-yielding thin magnetic coating materials used in the manufacture of magnetic recording heads. The deposited film maintains the stochiometry of the bulk alloy, exhibits an extreme hardness and wear resistance. Further, it not only retains the excellent magnetic properties but adheres very well to various substrate materials and offers a voidless, homogeneous, well-defined surface. Magnetic heads, with a .002" coating on the tracks, have been manufactured for a complete evaluation of their mechanical and electrical performance. Compared to HyMu 80 (a core material presently used for magnetic heads) the sputtered Alfesil coating has approximately 10 times higher resistance to wear with, consequently, approximately 10 times longer lifetime expectance for the same core tips under equal conditions. Author

N67-32525# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
LOW AND HIGH AMPLITUDE INTERNAL FRICTION MEASUREMENTS IN SOLIDS AND THEIR RELATION TO IMPERFECTION MOTIONS
W. P. Mason Mar. 1967 134 p refs
(Contract Nonr-266(91))
(TR-46; AD-652793) CFSTI: HC $3.00/MF $0.65

The mechanical properties of single crystal and polycrystalline metals are determined largely by imperfection motions. Internal friction measurements are very sensitive methods for studying these motions. Low amplitude and high frequency measurements are conventional. A new high amplitude system capable of measuring internal friction and modulus defects is described. This can make measurements of internal friction from 0.0001 to 0.2 with strain amplitudes up to 0.01. Typical data are shown for low amplitude, high frequency and high amplitude data. These are interpreted in terms of a modified Granato Lucke model. In the linear range dislocation drag coefficients are shown to be determined by the damping of phonons and electrons. The first non-linear range is associated with the breakaway of dislocations from pinning points. The final range involves the generation of new dislocations and is associated with instabilities and fatigue in the metal.

Author (TAB)

N67-32563# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACADEMY OF SCIENCES OF THE BELORUSSIAN SSR. PHYSICAL AND TECHNOLOGICAL INSTITUTE COLLECTION OF SCIENTIFIC PAPERS
2 Sep. 1966 15 p refs Transl. into ENGLISH from An. Bssr. Fiz.-Tekhn. Inst. Sb. Nauchn. Tr., Izd-Vo Nauka i Tekhn. (Minsk), 1964 p 124–133
(FTD-TT-65-1408, TT-67-60506; AD-645838)

CONTENTS:

1. INVESTIGATION OF THE MICROSTRUCTURE OF COPPER DEFORMED IN AN ULTRASONIC FIELD V. P. Severdenko and V. V. Klubovich p 1–6 ref (See N67-32564 18-17)
2. A STAND TO TEST MATERIALS FOR CREEP IN AN ULTRASONIC FIELD Ye. G. Konovalov and E. I. Remizovskiy p 7–12 refs (See N67-32565 18-11)

N67-32564# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE MICROSTRUCTURE OF COPPER DEFORMED IN AN ULTRASONIC FIELD
V. P. Severdenko and V. V. Klubovich *In its* Acad. of Sci. of the Belorussian SSR, Phys. and Technol. Inst. Collection of Sci. Papers 2 Sep. 1966 p 1–6 ref (See N67-32563 18-17)

Break zone microstructures of copper samples after elongation in ordinary condition and in an ultrasonic field showed that stretched grain formed around zones disturbed by static elongation. Elongation in an ultrasonic field produced less pronounced grain elongations. Microhardness measurements of the metal in the break zone under static and vibrational loads indicated that under ultrasonic oscillations, together with hardening, the process of softening also occurs. G.G.

N67-32576*# Aerojet-General Corp., El Monte, Calif.
DIMENSIONAL CHANGE OF STELLITE 6B DURING PHASE TRANSFORMATION FROM FACE-CENTERED CUBIC TO HEXAGONAL CLOSE-PACKED CRYSTAL STRUCTURE
H. E. Biell 3 Dec. 1965 8 p
(NASA-CR-72243; TM-4923-65-4-357) CSCL 11F

The linear dimensional contraction of Stellite 6B due to transformation from the face-centered cubic to the hexagonal close-packed crystal structure was determined in 18 parts using 91 individual measurements. The average contraction and the standard deviation of the 91 individual measurements were determined to be 0.092% and 0.042%, respectively. Author

N67-32578*# Michigan Univ., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena.
CAVITATION-EROSION CHARACTERISTICS OF SELECTED MATERIALS IN MERCURY AT 800°F
D. J. Kemppainen and F. G. Hammitt Apr. 1967 32 p refs
(Grant NsG-60-39)
(NASA-CR-87000; TR-03424-21-T) CSCL 11F

The tests were conducted in the ultrasonic vibratory facility, on pure niobium, pure tantalum and 9M steel (9% chromium, 1% molybdenum, 0.1% carbon). The pure niobium is by far the least resistant to cavitation attack, based on the mean depth of penetration (MDP) in mercury at 500°F. Pure tantalum is far better than niobium and the alloy 9M is the most damage resistant of the materials tested in this investigation. A comparison of test data from this program with data obtained previously under the same conditions indicates that alloys of both tantalum and niobium are more resistant to cavitation attack than are the pure materials. The alloy 9M is slightly more resistant to cavitation attack than 304 SS, but slightly less than 316 SS. The mechanical properties of the materials are compared with predicting equations for average MDP rate and show that hardness and tensile strength are the most useful parameters for prediction of relative cavitation resistance of these materials. Author

N67-32600*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COATINGS QUALITY ASSURANCE, SECTION VII
A. J. Hobbs and Ben Seidenberg *In its* Radiometry Progr. 1st Trimester, 1967 Apr. 1967 18 p (See N67-32594 18-23)

Eight getter-ion/titanium sublimation pumps with controls and power supplies, all meeting specifications, were received. Coatings research activities are reported, including the receipt of a black metallic oxide coating for vacuum chamber interiors. Thermal control coating adhesion on the Radio Astronomer Explorer (RAE) satellite solar paddle is discussed, including tests developed to check adhesions of various coatings under severe temperature conditions. A methyl silicon/rutile TiO_2 paint applied to a primed white substrate was found to offer the best solution for averting adhesion failure on the RAE satellite, but is emphasized that testing was based under severe temperature conditions rather than on simulated space conditions. The need for a meaningful quality control program is stressed. M.W.R.

N67-32634*# Rocketdyne, Canoga Park, Calif.
INVESTIGATION OF BIAXIAL STRESS CORROSION IN TWO ALLOY Final Report, 29 Jun. 1966–28 May 1967
A. J. Jacobs 19 Jun. 1967 49 p refs
(Contract NAS9-8324)
(NASA-CR-65846; R-7102) CFSTI: HC $3.00/MF $0.65 CSCL 11F

The effect of a biaxial (1:1) stress state on the stress-corrosion resistance of 7075-T6 aluminum and 347 stainless steel was determined. Tubular specimens of these alloys were loaded in simple tension or were loaded in tension and pressurized to obtain the biaxial stress state. A total of 40 aluminum specimens, 20 short transverse and 20 long transverse, were subjected to alternate-immersion tests in a 3-1/2 percent NaCl solution at room temperature. The short transverse specimens were tested at 65 and 32.5 percent of yield strength, and the long transverse specimens at 80 and 65 percent of yield. Forty-two stainless steel specimens were continuously immersed in a constant boiling (309°F) aqueous solution of $MgCl_2$. These were investigated at 50 and 65 percent of their yield strength. Balanced biaxial loading compared with uniaxial loading is as follows in its effect on stress-corrosion life. The short transverse 7075-T6 specimens tended to survive somewhat longer under biaxial loading; however, there was no discernible effect in the case of long transverse specimens. A tendency was observed for the lifetime of 347 stainless steel specimens to be shortened under the application of biaxial stress. Author

N67-32839*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DISLOCATION STRUCTURES IN SLIGHTLY STRAINED TUNGSTEN AND TUNGSTEN–RHENIUM AND TUNGSTEN–TANTALUM ALLOYS
Joseph R. Stephens Washington, NASA, Aug. 1967 21 p refs
(NASA-TN-D-4094) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Deformation substructures of polycrystalline tungsten, tungsten–2, 9, and 24 weight % rhenium, and tungsten–3 weight % tantalum were studied by transmission electron microscopy. The stress–strain curve for unalloyed tungsten shows gradual yielding followed by work hardening. Electron micrographs indicate a gradual increase in dislocation density with increase in strain up to 5.0%. Dislocations, although frequently jogged, are straight over moderate distances and are in a random array. The results indicate the primary effect of low rhenium concentrations (2 and 9%) in tungsten is to increase dislocation multiplication after macroyielding by reducing the Peierls–Nabarro force (lattice resistance to dislocation motion). The dislocation bands that precede twins in tungsten–24% rhenium may be caused by localized internal stresses resulting from a metastable structure, for example, clustering of rhenium atoms. Author

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-31538*# Southern Research Inst., Birmingham, Ala.
THERMOPHYSICAL PROPERTIES OF A LOW-DENSITY PHENOLIC–NYLON ABLATION MATERIAL
W. T. Engelke, C. M. Pyron, Jr., and C. D. Pears Washington, NASA, Jul. 1967 119 p
(Contract NAS1-2978)
(NASA-CR-809) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Some physical properties were determined on a low density phenolic nylon that was both nondegraded (virgin) and thermally degraded (charred). The low density phenolic nylon was a molded composite consisting of 25% phenolic resin, 35% phenolic microballoons, and 40% powdered nylon. The material was thermally charred in an arc tunnel. The thermal conductivity of the virgin material from −200°F to 750°F ranged from 1.27×10^{-5} Btu/sec/ft/°F (7.91 × 10^{-2} W/m/°K) to a maximum of 1.69×10^{-5} Btu/sec/ft/°F (10.5 × 10^{-2} W/m/°K). The thermal conductivity from 1000°F to 5000°F of the charred material increased from 11.5×10^{-5} Btu/sec/ft/°F (0.72 W/m/°K) to 76×10^{-5} Btu/sec/ft/°F (4.73 W/m/°K). During cooling the values were higher and more scattered, indicating further degradation at the higher temperatures and some shrinking and cracking of the specimens upon cooling. The heat capacity of the virgin material increased from 0.20 Btu/lb/°F (837 J/kg/°K) at −200°F to 0.58 Btu/lb/°F (2427 J/kg/°K) at 600°F. Author

N67-31676# Library of Congress, Washington, D. C. Aerospace Technology Div.
THERMAL AND THERMAL–OXIDATIVE DEGRADATION OF SOME HEAT-RESISTANT POLYMERS
Boris Nartsissov *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 58–68 refs (See N67-31676 18-34)

A survey is given of the thermal and thermal-oxidative stability of heat-resistant polymers of various classes, e.g., polybenzimidazoles, polyoxadiazoles, polypyromellitimides and some polyamides and polyethers. The Soviet attempts to stabilize the polymers by additives or to improve their heat resistance by the introduction of heteroatoms, such as O, P, or B into the backbone are described. Author

N67-31856*# Aerojet-General Corp., Azusa, Calif. Von Karman Center.
IMPROVED CRYOGENIC RESIN/GLASS-FILAMENT-WOUND COMPOSITES Final Report, 29 Jun. 1965–29 Mar. 1967
A. Lewis and G. E. Bush Apr. 1967 217 p refs
(Contract NAS3-6297)
(NASA-CR-72163; Rept.-3392) CSCL 11D

Composites fabricated with glass filaments and newly developed finish and resin systems yielded improved properties at room and cryogenic temperatures. Naval Ordnance Laboratory rings, flat filament-wound laminates, and 8-in.-dia filament-wound pressure vessels were tested. The glass reinforcement consisted of monofilaments, single-end roving, or 12-end roving. The finishes developed were compatible with both the glass surface and the matrix resins under evaluation. Author

N67-31992*# United Aircraft Corp., East Hartford, Conn. Research Labs.
INVESTIGATION OF THE KINETICS OF CRYSTALLIZATION OF MOLTEN BINARY AND TERNARY OXIDE SYSTEMS Quarterly Status Report, 1 Mar.–31 May 1967
J. F. Bacon 30 Jun. 1967 53 p refs
(Contract NASw-1301)
(NASA-CR-86606; QSR-7) CFSTI: HC $3.00/MF $0.65 CSCL 11B

Sixty-six additional new glass compositions were devised, successfully melted, and characterized. These glasses are grouped in five series, the National Bureau of Standards calcium–aluminate glasses formed the basis for calcium–yttria formulations, Stevels invert glasses were extended to include invert glasses based on silica–alumina and silica–yttria, the cordierite–sapphirine composition field was extended to include equal or greater amounts of rare-earth oxides, this same series of compositions were further modified by substituting calcia for magnesia, and finally the series was modified by replacing the alumina as a constituent by calcia, adding several additional glass-making oxides to lower the liquidus, to lower the density, to increase the working range, and to increase the viscosity, and increasing the rare-earth concentrations to the single largest constituent category. Author

N67-32008# Advisory Group for Aerospace Research and Development, Paris (France).
COMPOSITE MATERIALS [MATERIAUX COMPOSITES]
George Gerard and G. Dixmier May 1966 75 p In FRENCH and ENGLISH
(AGARD-524; AGARD-483) CFSTI: HC $3.00/MF $0.65

To obtain meaningful data on the cooperative work to be undertaken by the NATO countries, the choice, availability, and distribution of standard composites and constituents are specified. The constituents include beryllium wire, silica fibers, and epoxy resin matrix materials; the composites cover epoxy resin–silica fiber, phenolic resin–silica fiber, and aluminum matrix–beryllium wire. The materials are to be characterized in terms of physical and mechanical properties by the issuing source; single sources will fabricate standard composites for distribution. The administrative factors governing laboratory collaboration are discussed. Salient problem areas and research activities on composites are assessed, with attention focused on the role and important properties of the matrix, reinforcement, interface, and composite. Recommendations are made for specific research to improve industrial products, and for general research to increase knowledge of physical, chemical, and solid-mechanic phenomena which govern the behavior of composite materials. M.G.J.

N67-32398*# Stanford Research Inst., Menlo Park, Calif.
POLYMERS FOR SPACECRAFT HARDWARE Monthly Technical Progress Report, 10 Feb. 1967–1 Mar. 1967
R. F. Muraca, A. A. Koch, and J. S. Whittick 15 Mar. 1967 32 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950745; SRI Proj. ASD-5046)
(NASA-CR-85614; MTPR-33) CFSTI: HC $3.00/MF $0.65 CSCL 11I

A comprehensive test program was completed on 30 polymeric products for spacecraft applications to determine changes after a decontamination treatment, a thermal vacuum exposure, and a decontamination treatment followed by a thermal vacuum exposure. Polymer types included epoxy, fluorocarbon silicone, isobutylene/isoprene, polyamide, polyester, polyester–silicone, polyurethane, rubber resin–aluminum andglass, and silicone. Measurements included dielectric constant and dissipation factor, compression set, compression strength, adhesion shear, tensile and elongation, and T-peel measurements. Results are tabulated under the major categories of adhesives, foam materials, protective coatings, sealants, tapes, and tie cord/lacing tapes. Mention is made of micro and macro techniques related to a volatile condensable material, which is defined as the weight of condensate obtainable at 25°C in a given interval of time from a unit weight of a thin sample of material maintained at 125°C in a vacuum of at least 5×10^{-6} torr. M.W.R.

N67-32470 Joint Publications Research Service, Washington, D. C.
NEW HETEROCHAIN POLYMERS
V. V. Korshak 29 Jun. 1967 75 p refs Transl. into ENGLISH from the book "Progres v Polimarnoy Khimii" Moscow, 1965 p 220–269
(JPRS-41632; TT-67-32265) CFSTI: $3.00

Described are synthetic heterochain compounds which contain such heteroatoms as oxygen, nitrogen, and sulfur. Discussed are polyethers, polyesters, polyanhydrides, polysulfides, polysulfonates, polysulphones, polysamines, polyamides, polyurethanes, polazines and other nitrogen containing polymers with the >C=N– linkage, and polymers with nitrogen containing heterorings in the chain. S.C.W.

N67-32490*# Southern Research Inst., Birmingham, Ala.
THE PERMEABILITIES OF AN ELASTOMER, A LOW DENSITY EPOXY AND A LOW-DENSITY PHENOLIC-NYLON CHAR Final Report
30 Jun. 1967 58 p refs
(Contract NAS1-5448)
(NASA-CR-66435) CSCL 11J

The permeabilities of an elastomer, a low-density epoxy and a low-density phenolic-nylon ablation char were measured at room temperature for helium and nitrogen as separate permeating gases. The permeabilities were determined in terms of the viscous flow coefficient (reciprocal of Darcy's constant) and the inertial flow coefficient. The permeability of the char was evaluated as a function of temperature from room temperature to 810°K (1000°F) and as a function of direction within the char. The results indicate that the flow resistance of the char decreases with increasing temperature. Some directional effects were observed, but the results were not strongly conclusive. Author

N67-32581*# TRW Systems Group, Redondo Beach, Calif.
STUDY TO DETERMINE THE THERMOPHYSICAL PROPERTIES OF ABLATIVE MATERIALS Summary Report
F. E. Arndt Jun. 1967 12 p ref
(Contract NAS9-4518)
(NASA-CR-65545; TRW-04812-6002-R000) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Thermophysical properties of the following ablative materials were determined: Fiberite MX 2600; HITCO Irish Refrasil/phenolic resin; Refrasil cloth/elastomeric modified phenolic resin; Fiberite

MX 2646; and magnesium hydroxide/phenolic resin. Properties determined were specific heat, density, thermal conductivity, thermal diffusivity, and surface emissivity (all for virgin and char). Resin decomposition (charring) temperatures and melting temperatures were also determined. In addition, ablative liners instrumented with surface and in-wall thermocouples were tested for in-wall temperature responses for both the virgin and charred ablative liners. Heat flux measurements were also taken to characterize the wall thermal environment as a function of injection parameters. Comparisons made between maximum measured surface temperatures obtained from the ablative test firing with those obtained from laboratory measurements showed good agreement.
L.S.

N67-32601*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COATINGS DEGRADATION, SECTION VIII
Carmen A. Nicoletta *In its* Radiometry Progr. 1st Trimester, 1967 Apr. 1967 20 p (See N67-32594 18-23)

Existing test facilities and projected new ones are discussed for vacuum chambers used in particle irradiation of thermal control coatings. Paint samples of both alkali silicates and methyl silicones were tested when exposed to 1 MeV, 700 keV and 400 keV at fluence of 10^{14} electrons/cm^2 in a vacuum of 10^{-6} ton. At 1 MeV there are no changes in optical reflectance observed, but at 700 keV there is a definite visible change that is seen immediately upon removing the specimen from the chamber. At 400 keV reflectance change is estimated around 1.0 to 3.0%. Since the flux of all energy beams was the same, it is considered unlikely that the change at 700 keV was due to the effect of electron bombardment.
M.W.R.

N67-32642# State Univ. of New York, Stony Brook. Coll. of Engineering.
PREFERENTIAL ATTACK ON COUPLING AGENT TREATED GLASSES Final Report
Sumner N. Levine and William C. Lacourse [1967] 14 p refs
(Contract Nonr-4803(00))
(AD-652408) CFSTI: HC $3.00/MF $0.65

The paper constitutes a final report on a study of the surface properties of glasses as they relate to the glass-polymer interfacial bonding in glass reinforced plastics. A brief review of the findings of two previous reports is given, and the results of titration and electron microscopy studies of E and 994 glasses treated with coupling agents is included. The results indicate that preferential sites for aqueous attack found in the previous work on clean glass surfaces are present on the glasses treated with the coupling agents. A summary of the results of the work is also included.
Author (TAB)

N67-32662# IIT Research Inst., Chicago, Ill.
AN INVESTIGATION OF THE FATIGUE AND CREEP PROPERTIES OF GLASS REINFORCED PLASTICS FOR PRIMARY AIRCRAFT STRUCTURES Final Report 1 May 1965–1 Dec. 1966
K. E. Hofer, Jr. and E. M. Olsen Apr. 1967 257 p refs
(Contract NOw-65-0425)
(IITRI-M6104; AD-652415) CFSTI: HC $3.00/MF $0.65

Fatigue of glass reinforced epoxy composite materials is examined from several points of view. High cycle and low cycle fatigue and the effects of frequency, moisture, and state of stress on the fatigue life are included. The effects of creep and strain rate are also studied with a view toward their effect on fatigue life. Cumulative fatigue damage studies include nondestructive ultrasonic techniques applied to damage levels and application of phenomological theory to the results of two stress level testing. Appendices accompanying the report include (1) a survey of GRP fatigue literature, and (2) a survey of existing cumulative fatigue damage theories with potential application to GRP. Two types of reinforcement were used, uniaxial roving and glass cloth.
Author (TAB)

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-31517# Cornell Univ., Ithaca, N. Y. Dept. of Industrial Engineering and Operations Research.
PHASE TYPE SERVICE WITH DIFFERENT SERVICE RATES
Atma P. Lalchandani Oct. 1966 16 p refs
(Contract Nonr-401(55))
(TR-17; AD-652396) CFSTI: HC $3.00/MF $0.65

Customers arrive in a Poisson process at a single-server queuing system and demand a fixed number of phases of service, each phase requiring a negative exponentially distributed time with different parameters. This system is analyzed by considering the bivariate Markov process (Q(t), R(t)) where Q(t) is the queue-length and R(t) the number of residual service phases of the customer at time t. The non-Markovian process (Q(t)) is the marginal of this bivariate process.
TAB

N67-31541# Stanford Univ., Calif. Dept. of Computer Science.
COMPUTATIONAL CONSIDERATIONS REGARDING THE CALCULATION OF CHEBYSHEV SOLUTIONS FOR OVERDETERMINED LINEAR EQUATION SYSTEMS BY THE EXCHANGE METHOD
Richard H. Bartels and Gene H. Golub 2 Jun. 1967 67 p refs
(Contract Nonr-255(37))
(CS-67; AD-652922) CFSTI: HC $3.00/MF $0.65

An implementation, using Gaussian LU decomposition with row interchanges, of Stiefels exchange algorithm for determining a Chebyshev solution to an overdetermined system of linear equations is presented. The implementation is computationally more stable than those usually given in the literature. A generalization of Stiefels algorithm is developed which permits the occasional exchange of two equations simultaneously. Finally, some experimental comparisons are offered.
Author (TAB)

N67-31554# California Univ., Berkeley. Operations Research Center.
CHANCE-CONSTRAINED EQUIVALENTS OF SOME STOCHASTIC PROGRAMMING PROBLEMS
Gifford H. Symonds May 1967 16 p refs
(Grant NSF GP-4593)
(ORC-67-18)

Chance-constrained equivalents are shown to exist for several stochastic programming problems concerned with selecting a decision vector which will optimize the expectation of a random loss function, sometimes subject to deterministic constraints. The equivalent chance-constrained problems are concerned with selecting a decision vector which will optimize a deterministic function subject to one or more probability constraints of the form $Pr\{y_i \geq Z_i\} \geq \alpha_i$, $i \in I$, and sometimes also subject to deterministic constraints. Equivalence is shown for stochastic programming problems with either linear or nonlinear random loss functions, including many stochastic scheduling and inventory problems. Such stochastic programming problems may be converted to equivalent chance-constrained problems which can be solved in their certainty equivalent form, for example, by the Horizon Method of Stochastic Scheduling.
Author

N67-31555# Montana State Univ., Missoula. Computer Center.
MATRIX SOLUTION OF FREDHOLM INTEGRAL EQUATIONS OF THE SECOND KIND
D. R. Arterburn Jun. 1967 9 p refs
(TR-10)

A numerical technique for solving the Fredholm Integral Equation of the second kind $f(x) = g(x) + \lambda \int K(x, t)f(t)dt$ where f and g are continuous real-valued functions defined on [0, 1] and K is a continuous real-valued function defined on [0, 1] × [0, 1]. The technique is, of course, valid on any closed interval [a, b] in place of [0, 1], and [0, 1] is used for ease of notation. The technique consists of approximating the integral operator by a matrix and finding an approximate solution f by inverting the matrix. Author

N67-31719# Oak Ridge National Lab., Tenn.
MATHEMATICS DIVISION Annual Progress Report, Period Ending 31 Dec. 1966
Manuel Feliciano, Jr. comp. Apr. 1967 127 p refs
(Contract W-7405-ENG-26)
(ORNL-4083) CFSTI: HC $3.00/MF $0.65

An annual progress report is presented on mathematics and computing and mathematical statistics at ORNL during the period ending December 31, 1966. Topics include research; computing services; and statistical research, programming, and applications. NSA

N67-31744*# Ohio State Univ. Research Foundation, Columbus.
RANKING PROBLEMS IN MULTIVARIATE NORMAL (STATISTICAL) POPULATIONS Final Report, 1 Jul. 1966–30 Jun. 1967
M. Haseeb Rizvi 6 Jul. 1967 3 p
(Grant NGR-36-008-040; Proj. RF-2241)
(NASA-CR-85594; Rept.-2) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The selection of t out of k non-central chi-squared and non-central F populations with the largest non-centrality parameters was solved. Also considered was the problem of selecting a subset containing the t populations with largest non-centrality parameters. Suitable procedures were developed for these problems, and their operating characteristics were studied. An application of a parametric distance function to measurement signal-to-noise ratio in communications theory is given. Differential difference equations involving non-central chi-squared distribution and density functions were obtained for solving minimization problems. Some preliminary results were also obtained for the nonparametric selection procedures for comparing several univariate distributions with a control. K.W.

N67-31865 Joint Publications Research Service, Washington, D. C.
THEORY OF LARGE SYSTEMS
Ya. Z. Tsypkin 21 Jun. 1967 68 p refs Transl. into ENGLISH from the book "Kibernetika i Upravleniye" Moscow, Izd. Nauka, 1967 p 85–130
(JPRS-41494; TT-67-32127) CFSTI: $3.00

CONTENTS:

1. OPTIMUM PLANNING OF SEQUENCE OF OPERATIONS PERFORMED BY ONE OR TWO MACHINES N. M. Lobanovskiy p 1–11 (See N67-31866 18-19)
2. CERTAIN PROBLEMS IN CONSTRUCTION OF MODELS FOR OBJECTS OF CONTROL F. A. Ovsepyan p 12–17 refs (See N67-31867 18-19)
3. THE METERING PROPERTIES OF TREES A. K. Kal'mans p 18–31 refs (See N67-31868 18-19)
4. A METHOD OF CONTROLLING A COMPLEX INDUSTRIAL OBJECT K. V. Tomingas p 32–36 refs (See N67-31869 18-19)
5. OPTIMUM CONTROL OF SYSTEMS OF INDEPENDENT OBJECTS V. N. Burkov p 37–41 refs (See N67-31870 18-19)
6. THE CONSTRUCTION OF THE SHORTEST CONNECTING NETWORK A. K. Kal'mans p 42–60 refs (See N67-31871 18-19)

N67-31866 Joint Publications Research Service, Washington, D. C.
OPTIMUM PLANNING OF SEQUENCE OF OPERATIONS PERFORMED BY ONE OR TWO MACHINES
N. M. Lobanovskiy *In its* Theory of Large Systems 21 Jun. 1967 p 1–11 (See N67-31865 18-19)

An algorithm is developed which makes it possible to reduce considerably the simple operations of the mechanism for the problem of planning the sequence of operations requiring no readjustment in one machine and the so-called traveling salesman's problem. This article shows how these two problems can be generalized in planning the sequences by taking into account the readjustments for two cases: when any operation can be started at any moment of time, and when the work enters the machine in accordance with a specified schedule. Also under consideration is a stochastic version of a case of planning the sequence of operations on two machines, when the time for performing the work by the machines has a random value. It provides the procedure for obtaining an optimum sequence resulting in a minimum average time required to complete all operations. Author

N67-31867 Joint Publications Research Service, Washington, D. C.
CERTAIN PROBLEMS IN CONSTRUCTION OF MODELS FOR OBJECTS OF CONTROL
F. A. Ovsepyan *In its* Theory of Large Systems 21 Jun. 1967 p 12–17 refs (See N67-31865 18-19)

Mathematical expressions governing probability distribution functions were derived which are useful in certain problems concerning the wear of tools during the machining of parts, temperature variations in high speed cutting, and other similar problems. Mathematical expectation and dispersion as a function of time elapsed are examined. An example is considered in which the conditional density for a process of grinding the outside diameter of a ball bearing raceway on a centerless type automat of the automatic line of a ball bearing plant, is determined. The expression obtained is presented, and the distribution curve depicted. Results were checked with the aid of Kolmogorov's criterion, and indicate agreement between the theoretical distribution and the experimentally obtained data. L.S.

N67-31868 Joint Publications Research Service, Washington, D. C.
THE METERING PROPERTIES OF TREES
A. K. Kal'mans *In its* Theory of Large Systems 21 Jun. 1967 p 18–31 refs (See N67-31865 18-19)

The measuring properties of compact tree-graphs were investigated. The necessary and adequate conditions for realizing a matrix in the form of a certain tree are furnished. Algorithms for constructing a tree, using its distances matrix, are presented. It is shown that each apex of a tree is single-valuedly (and with almost isomorphic accuracy) determined by a set (s-1) of numbers (s is the number of suspended apexes of the tree). L.S.

N67-31869 Joint Publications Research Service, Washington, D. C.
A METHOD OF CONTROLLING A COMPLEX INDUSTRIAL OBJECT

K. V. Tomingas *In its* Theory of Large Systems 21 Jun. 1967 p 32–36 refs (See N67-31865 18-19)

Mathematical functions are considered for stabilizing systems described by linear differential equations with constant coefficients and for systems based on the Robbins and Monro stochastic approximation procedure. It is shown that the use of the latter system is more expedient in many cases. It is also noted that all the advantages of the stochastic approximations used in regulation are also valid in using the Kiefer–Wolfowits stochastic procedure where an extremum of the output parameter is found. L.S.

N67-31870 Joint Publications Research Service, Washington, D. C.

OPTIMUM CONTROL OF SYSTEMS OF INDEPENDENT OBJECTS

V. N. Burkov *In its* Theory of Large Systems 21 Jun. 1967 p 37–41 ref (See N67-31865 18-19)

A series of problems (oriented by mathematical functions) concerning the optimal control of systems of independent objects are considered. Certain parameters of the controlling action are determined with respect to time and the state of the system. Expressions obtained from the calculations concerning the particular system, are presented. L.S.

N67-31871 Joint Publications Research Service, Washington, D. C.

THE CONSTRUCTION OF THE SHORTEST CONNECTING NETWORK

A. K. Kal'mans *In its* Theory of Large Systems 21 Jun. 1967 p 42–60 refs (See N67-31865 18-19)

Geometric constructions illustrating the physical model of a matrix problem which makes it possible to notice the properties of stable networks (in which a local minimum is obtained), are presented, and are discussed. Certain necessary conditions for constructing an optimum network are described, and algorithms for constructing networks close to optimum are given. Examples of constructions of shortest connecting nets (trees) for certain particular cases are also presented. L.S.

N67-31982# Information Research Associates, Inc., Lexington, Mass.

ON THE APPLICABILITY OF WIENER'S CANONICAL EXPANSIONS

Donald B. Brick 20 Mar. 1967 26 p refs Presented at the IEEE Intern. Conv., 20 Mar. 1967

(Contracts Nonr-4752(00); AF 49(638)-1631; AF 33(615)-3758) (TR-8; AD-650193) CFSTI: HC $3.00/MF $0.65

In previous papers, the application of Wiener's Hermite–Laguerre expansion procedure to the multiple-alternative discrete-decision problem, with learning, characteristic of many pattern recognition problems was proposed. The applicability to problems in cybernetics, intelligence, and learning of the resulting Bayes' type system was discussed. In the present paper the results of a subsequent analytical investigation which included a digital simulation of the procedure are summarized. Emphasis is on the aspects of realizability, convergence, and applicability of the method as regards the classes of stochastic inputs for which the procedure is valid. Author (TAB)

N67-31983*# GCA Technology Div., GCA Corp., Bedford, Mass.

ERROR ANALYSIS OF INVERSION TECHNIQUES Final Report

E. T. Florance Jun. 1967 50 p refs

(Contract NAS5-3352)

(NASA-CR-86626; GCA-TR-67-8-N) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The background of the nonlinear inversion method is briefly described. A specific form of the nonlinear technique has been developed to infer unique atmospheric temperature profiles from satellite radiometer data. This particular version of nonlinear inversion utilizes the ground temperature, as sensed in a spectral window, to fix the inferred profile, which consists of a set of ramp functions. Application of the nonlinear algorithm to a spectral scan necessitates the approximation of actual band transmittances with an exponential model. A mathematical technique for fitting transmittance data is described, together with details of a computer program to accomplish this task. An error analysis of the nonlinear inversion algorithm is being performed by a computer program called INVERSIM. This program performs the inversion of noisy synthetic radiance data calculated at those frequencies which are optimal for Prony's method to apply. Details of INVERSIM and its component subroutines are presented with appropriate flow charts. The INVERSIM program has been applied to the 691 to 712.5 cm^{-1} region of the 15 micron band of carbon dioxide using typical model atmospheres. The results of attempting to infer two and three ramp profiles are analyzed with respect to noise level. It is concluded that the window radiance method is not a stable inversion algorithm for the above frequency region. Author

N67-32087*# Kent State Univ., Ohio. Dept. of Mathematics.

A MAXIMIZATION PROBLEM IN THE THEORY OF PARTITIONS

Russell A. Smucker (M.A. Thesis) Jun. 1967 54 p

(Grant NsG-568)

(NASA-CR-86613; TR-25) CSCL 12A

Two generalizations of the following problem in the theory of partitions of integers are studied: maximize the sum of the products of all pairs of adjacent terms in an ordered p-tuple subject to the restriction that the coordinates be positive integers whose sum is fixed ($p \geq 2$). The problem of maximizing the sum of the products of all ordered q-tuples of adjacent terms in an ordered p-tuple subject to the restriction that the coordinates be positive integers whose sum is fixed ($2 \leq q \leq p$). An explicit description of a p-tuple which yields the maximum and use it to find an approximation for the maximum. The problem is altered by allowing the coordinates to be nonnegative real numbers. A p-tuple yielding the maximum is displayed, and used to find an explicit expression for the maximum. Author

N67-32088# California Univ., Livermore. Lawrence Radiation Lab.

A PROCEDURE FOR INTERPOLATING BIVARIANT DATA INFLUENCED BY RANDOM ERROR

J. H. Van Sant 31 Mar. 1967 12 p refs

(Contract W-7405-ENG-48)

(UCRL-50219) CFSTI: HC $3.00/MF $0.65

An *ad hoc* method of interpolating bivariant data influenced by random error is proposed that selects an optimum number of local data points to permit a best estimate of Y*, the dependent variable. A sample problem is presented to illustrate the effectiveness of the proposed interpolation when Y(X) is a quadratic. A Fortran II computer program subroutine, TDI (test data interpolation), is included that accounts for random error; and an alternate curve-segment method is discussed. M.W.R.

N67-32149*# Kent State Univ., Ohio. Dept. of Mathematics

COVERED SPACES

Joel E. Edelman Aug. 1967 31 p refs

(Grant NsG-568)

(NASA-CR-86920; TR-26) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The extent to which elementary properties of the basic concepts of topology remain valid is examined in the more general

concept of covered spaces. It is shown that virtually all the properties of the topological operations of closure, interior, and derivative are retained despite the weak hypotheses. Several of the basic properties of set functions and of the separation axioms are shown to hold true under these general conditions. A particular form of disconnectedness for arbitrary subsets in a space is investigated, and it is found that extreme degrees of connectedness are accompanied by specific topological properties. A limit point diagraph corresponding to a covered space in terms of singleton set limit points is defined. It is shown that a connected diagraph can represent only a space that is connected in the particular sense mentioned, but that the converse relation may not necessarily hold. It is shown that one-to-one correspondence exists between simplicial maps of these diagraphs and a class of set functions which, on topological spaces, are homeomorphisms. S.P.

N67-32153# Illinois Univ., Urbana. Biological Computer Lab.
A CLASSIFICATION OF MAPPINGS BETWEEN FINITE SETS AND SOME APPLICATIONS
Dieter J. Schadach 1 Feb. 1967 31 p refs
(Grant AF-AFOSR-480-64)
(BCL-2.2; AFOSR-67-1080; AD-652234) CFSTI: HC $3.00/MF $0.65

This theoretical report also outlines applications for an edge detector and for relationships between information theory and the algebraic theory of machines. TAB

N67-32198# Joint Publications Research Service, Washington, D. C.
COMPARATIVE EVALUATION OF OPTIMAL METHODS OF CONTROLLING A MONOTONICALLY INCREASING RANDOM PROCESS WITH INDEPENDENT INCREMENTS
Ye. Yu. Barzilovich and S. K. Zakharenko *In its* The Reliability of Complex Tech. Systems 29 Jun. 1967 p 90–122 refs (See N67-32193 18-15)

Two optimal methods of controlling a monotonically increasing random process with independent increments are described: control according to mean statistical characteristics and control according to individual realizations. The conclusion that the latter method, given specific conditions, provides a marked gain in reliability is substantiated. Author

N67-32236# Joint Publications Research Service, Washington, D. C.
CONSTRUCTION OF MATRIX TYPE LOGIC SYSTEMS IN DIGITAL COMPUTERS
L. A. Orlov *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 223–241 refs (See N67-32222 18-07)

The advantages of digital computers using matrix type logic circuits based on ferrite cores are discussed and methods for their construction are analyzed. Examples of various matrix type circuits are given, including a counter and an adder. Elements for communication between matrices and methods for suppressing interference are also described. R.N.A.

N67-32237# Joint Publications Research Service, Washington, D. C.
COUNTERS IN GREY CODE
M. V. Chkheidze *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 252–262 refs (See N67-32222 18-07)

When analog-code tranformations are used in automatic control systems, such as in readout converters, large errors occur due to the ambiguity of the transformations arising when the quantity to be transformed lies on the boundary between two neighboring levels. Grey code counters can eliminate this ambiguity by representing the output number pulse code in the form of Grey code. Grey code counters can also be used in multichannel converters with voltage scanning, where information is removed from the counter in the process of reading without stopping the operation of the device. An analysis is made of the logic circuit of the Grey code counter, using analogous expressions for the binary code. R.N.A.

N67-32238# Joint Publications Research Service, Washington, D. C.
COMPARISON OF NUMBERS REPRESENTED IN GREY CODE
M. V. Chkheidze *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 263–274 refs (See N67-32222 18-07)

The Grey code cannot be directly used in computers which represent numbers in normal binary code. Additional devices must be used to convert the Grey code to binary code at the computer inputs. In systems with large numbers of analog–digital converters outputting Grey code, a comparison can be made directly in Grey code. The value of the standard settings is fixed in advance in either code, including Grey code, or translated from binary code to Grey code according to a program. In comparing numbers in both binary and Grey codes, the signs and weight functions of identical bit positions are taken into consideration. In the case of inequality of the codes, inequality of at least one set of identically numbered bit positions must follow. The conditions of equality and inequality of codes being compared are true for both binary and Grey codes, while the determination of the sign of the inequality in comparing Grey codes or Grey code with binary code is very difficult due to the necessity of considering the inconstant weight function of the bit positions for Grey code. A method is described for comparing both Grey code numbers and numbers represented in binary code. R.N.A.

N67-32242# Joint Publications Research Service, Washington, D. C.
ARITHMETIC OPERATIONS IN BINARY CYCLICAL CODE
M. V. Chkheidze *In its* Cybernetics in the Service of Communism, Vol. 3 29 Jun. 1967 p 302–314 refs (See N67-32222 18-07)

A method of performing the addition and subtraction operations in binary cyclical codes is analyzed. By using this method a considerable simplification and increase in operation speed of the adder are achieved. The method is shown to be of practical use in digital systems of automatic control. R.N.A.

N67-32288# Montana State Univ., Missoula. Computer Center.
A GENERAL ITERATIVE METHOD FOR NONLINEAR EQUATIONS
Charles Bryan Jun. 1967 15 p refs
(TR-9)

Presented is a general method of iteration for solving nonlinear equations of the type $P(x)=0$ where P is a mapping from one Banach space into another. A special case of the general method will yield results on the method on nonlinear simultaneous displacements introduced by H. M. Lieberstein. The procedure used to formulate the general method is analyzed and conditions are found which are sufficient to guarantee both the feasibility and convergence of the method. Results are restated for a strengthened result on the convergence of nonlinear simultaneous displacements. S.C.W.

N67-32312*# Analytical Mechanics Associates, Inc., Uniondale, N. Y.
CONVERGENCE ACCELERATION FOR LEAST SQUARES DIFFERENTIAL CORRECTIONS
Samuel Pines and Henry Wolf [1967] 6 p
(Contract NAS5-2535)
(NASA-CR-86997) CFSTI: HC $3.00/MF $0.65 CSCL 12A

A method for accelerating the convergence of least squares differential correction iteration schemes is considered. The method permits the solution of differential correction processes when strongly nonlinear effects result in slow convergence. Author

N67-32464# Harry Diamond Labs., Washington, D. C.
GENERATING FUNCTIONS WITH INTEGRATORS
Arthur Hausner Mar. 1967 53 p refs
(HDL-TR-1341; AD-652729) CFSTI: HC $3.00/MF $0.65

Generalized integration is a technique for generating explicit functions on an analog computer by solving the appropriate differential equations. The parametric technique is recommended for setting up the solutions. The summation and linear equipment theorems are shown to extend the use of linear equipment. Many examples illustrating the usefulness of these techniques are described, including generation of high degree oscillatory polynomials. A discussion on the use of multipliers contains a description of a technique for rational function generation. Track-and-store methods are also discussed. An important theorem concerning the use of linear equipment in this method is proved, with an example to show its effectiveness. The major advantage of these techniques is achievement in some cases of great accuracy with minimum equipment. The major disadvantage is that, with time, errors may sometimes increase and may not be bounded. TAB

N67-32485*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGNS OF EXPERIMENTS AS TELESCOPING SEQUENCES OF BLOCKS FOR OPTIMUM SEEKING (AS INTENDED FOR ALLOY DEVELOPMENT)
Arthur G. Holms Washington, NASA, Aug. 1967 54 p refs
(NASA-TN-D-4100) CFSTI: HC $3.00/MF $0.65 CSCL 12B

Box–Wilson methods of design and analysis are proposed for optimum seeking experiments. These methods begin with a first-order polynomial equation fitted to empirical data to predict those modifications that should result in the greatest improvement. The predictions are usually tested with new experiments and a new first-order prediction equation is fitted. If the vicinity of the optimum has been reached, the response function will be curved and a second-order equation is fitted to a much larger experiment. Ideally, the designs of the experiments should have two attributes: (1) If a minimum experiment to fit a first-order equation has been performed and the model is thought to be of doubtful validity, a larger experiment should be performed that will contain the earlier experiment as a nucleus. In this way a telescoping sequence of experiments might be performed up to the largest size envisioned in Box–Wilson methods, namely, the experiment to estimate the full second-order equation. (2) The constants of the larger equations should be estimated without bias by uncontrolled changes that may have occurred in the material or equipment between the performances of the experiments. The designs consist of full and fractionally replicated two-level factorial experiments with four to eight factors. The sizes of the experiments include 8, 16, 32, and 64 treatments. Author

N67-32527# Wisconsin Univ., Madison. Dept. of Statistics.
EXPERIMENTAL STRATEGY
G. E. P. Box Apr. 1967 19 p refs Presented at the Intern. Biometrics Conf., Sydney, Sep. 1967
(Contract Nonr-1202(17))
(TR-111; AD-653273) CFSTI: HC $3.00/MF $0.65

In this paper the basic iterative nature of experimental learning process is emphasized. The role of iteration is then discussed for a number of specific classes of problems. Those include the screening of variables, empirical model building, mechanistic model fitting. Recent contributions to the important problem of mechanistic model building are emphasized. TAB

N67-32546# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
A SURVEY OF RECENT MATHEMATICAL PUBLICATIONS ON THE SUBJECT OF CURVE CROSSINGS BY STOCHASTIC PROCESSES
Gordon B. Crawford Apr. 1967 20 p refs
(DI-82-0613; AD-652418) CFSTI: HC $3.00/MF $0.65

The report is prompted by the rash of good mathematical research on the problem of the moments of the number of crossings of a curve by a stochastic process. It is felt that this problem is important to some engineers and designers who may find a brief introduction to these recent publications useful. Author (TAB)

N67-32551*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THEORETICAL SOLUTION OF THE NONLINEAR PROBLEM OF TRANSIENT COOLING OF AN OPAQUE SPHERE IN SPACE
Ernst W. Adams and H. Spreuer Washington, NASA, Aug. 1967 13 p
(NASA-TN-D-4048) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The temperature distribution $T(r, t)$ in homogeneous opaque spheres with constant radius $r = R$ and constant initial temperature $T_0 = T(r, 0)$ is represented as a closed-form solution of Fourier's equation when heat is radiated from the surface $r = R$ into a vacuum. Substitution of the boundary conditions at $r = 0$ and $r = R$ into this solution yields a system of two nonlinear integro-differential equations for $T(R, t)$ and $T(0, t)$. These equations are solved numerically. Results for $T(r, t)$ are presented for spheres made of quartz with $R = 1$ cm, $R = 15.3$ cm, and $R = \infty$. One application of the solution is to determine the temperature history of meteorite ejecta traveling in space. Author

N67-32635*# Brown Univ., Providence, R. I. Center for Dynamical Systems.
ON THE STABILITY OF SOME LINEAR NONAUTONOMOUS SYSTEMS
E. F. Infante [1967] 27 p refs
(Contract NAS8-11284; Grant NGR-40-002-015)
(NASA-CR-86555) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Consideration is given to the stability of systems described by differential equations with time varying coefficients. Specialized norms used to reduce vector differential equations to scalar equations are extended so that they are applicable for any quadratic norm. This is done through the use of well known results on pencils of quadratic forms. The theorem and two corollaries obtained in this manner are then applied to the determination of conditions for the stability of second order equations, for which it is possible to obtain the optimum quadratic norm. C.T.C.

N67-32837# California Univ., Berkeley. Operations Research Center.
THE SYMMETRIC ASSIGNMENT PROBLEM
Katta G. Murty Feb. 1967 23 p refs
(Contract Nonr-222(83))
(ORC-67-12; AD-653103) CFSTI: HC $3.00/MF $0.65

A branch and bound algorithm for finding the minimal cost symmetric assignment is discussed. The matching problem in graph theory and the Chinese Postman puzzle are all special cases of the symmetric assignment problem, and hence this algorithm can be applied to solve them. TAB

N67-32665# North Carolina Univ., Chapel Hill. Dept. of Statistics.
ON THE DISTRIBUTIONS OF THE TIMES BETWEEN EVENTS IN A STATIONARY STREAM OF EVENTS
M. R. Leadbetter May 1967 12 p refs *Its* Mimeo Ser. No. 524
(Contract Nonr-855(09))
(AD-652364) CFSTI: HC $3.00/MF $0.65

Many authors - particularly in the physical and engineering sciences - have considered the problem of obtaining the distribution of the time between successive axis-crossings by a stochastic process. More generally, one may consider the distribution of the time between an axis-crossing and the nth subsequent axis-crossing, or between, say, an upcrossing of the axis and the nth subsequent downcrossing. TAB

N67-32666# California Inst. of Tech., Pasadena. Dept. of Mathematics.
ON SOME PROPERTIES OF BOUNDED INTERNAL FUNCTIONS
R. F. Taylor Apr. 1967 10 p refs
(Contract N00014-66-C0009-A04)
(TR-3; AD-653072) CFSTI: HC $3.00/MF $0.65

Let R be the real number system and let R^* be an ultrapower of R which is an enlargement of R. If omega is an infinitely large natural number, then the following bounded internal functions sin x omega, x epsilon R^* are considered. It is shown that the function f sub omega (x) = (sin omega x), x epsilon R is either sin ax for some a or is unmeasurable. Arithmetical conditions for omega are given in order that f sub omega is not measurable. It is also shown that there exists an infinitely large natural number omega such that sin omega x does not equal 0 but f sub omega identically equals 0. An application to integration theory is given. TAB

N67-32682# RAND Corp., Santa Monica, Calif.
GAMES WITH UNIQUE SOLUTIONS WHICH ARE NONCONVEX
W. F. Lucas May 1967 10 p
(Contract F44620-67-C-45)
(RM-5363-PR; AD-652649) CFSTI: HC $3.00/MF $0.65

Describes an eight-person Von Neumann-Morgenstern game with a solution of a type not previously reported: a polyhedron within four dimensions, unique and nonconvex. Previously known unique solutions have always been convex polyhedrons. The essential idea is the existence of a line L with a large Dom L. This property can be generalized in many dimensions in such a way as to describe many other games that maintain the corresponding L as a subset of the core. Large classes of interesting solutions will be obtained, many of them unique and nonconvex. These results suggest the possibility that not all n-person games have solutions, probably the most important unresolved issue in game theory. TAB

N67-32686# RAND Corp., Santa Monica, Calif.
STATISTICAL CONSIDERATIONS IN COMPUTER SIMULATION EXPERIMENTS
George S. Fishman May 1967 8 p refs Presented at the Computer Sci. and Statistics: A Symp. on the Interface Conf., Los Angeles, 1 Feb. 1967 Submitted for publication
(P-3608; AD-653174) CFSTI: HC $3.00/MF $0.65

This report discusses some statistical questions related to the analysis of digital computer simulation experiments. The remarks are confined to systems simulations that are or that contain queueing networks; for example, inventory models and job shop manufacturing facilities. The basic assumption is that these systems contain elements of random behavior so that the system output is a random variable. This paper describes some fundamental statistical problems that should be recognized in a simulation experiment from the initial phase of problem definition through the final stage of analysis of results. TAB

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-31660# Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology.
FREQUENCY OF OCCURRENCE OF RAIN ATTENUATION OF 10 DB OR GREATER AT 10 GC Final Report
Pauline M. Austin Dec. 1966 40 p refs Prepared for Lincoln Lab.
(Contract AF 19(628)-5167)
(ESD-TR-67-241; AD-652498) CFSTI: HC $3.00/MF $0.65

An analysis of quantitative radar data supplemented by records of hourly precipitation amounts and excessive short duration rainfall at selected points was made to determine the frequency of occurrence of severe attenuation (defined here as 10 db or more) of 10 Gc radiation by rain at stations in central New England. The study was based on two years data. It was found that at an elevation of 5 degrees above the horizon severe attenuation by intense thunderstorms may be expected for approximately 32 hours per year if all directions of propagation are involved. Along a particular azimuth it occurs for 5 hours per year. At an elevation angle of 10 degrees the times are 14 and 3 hours respectively; at 20 degrees they are 3-1/2 and 1-1/3 hours. Coarse resolution of the radar data precluded analysis at higher elevation angles. Severe attenuation by heavy widespread rain is considerably more probable in southeastern New England, where approximately 4 hours per year at 5 degrees elevation may be expected, than farther to the north and west. This type of storm does not cause as much as 10 db of attenuation at an elevation of 10 degrees or more. Techniques are suggested for applying the results to regions where rain gauge records but no quantitative radar data are available. Results of this preliminary analysis cannot be extended to higher radiation frequencies or smaller amounts of attenuation, because less intense storms whose statistics have not yet been thoroughly explored would be involved. An investigation of all types of New England storms, their intensities, their frequency of occurrence and the attenuation they would cause is in progress. Author (TAB)

N67-31663# National Severe Storms Lab., Norman, Okla.
THUNDERSTORM CIRCULATIONS AND TURBULENCE STUDIES FROM AIRCRAFT AND RADAR DATA
James C. Frankhauser and J. T. Lee Apr. 1967 37 p refs
(ERTM-NSSL-32) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ASSOCIATION BETWEEN ATMOSPHERIC TURBULENCE AND RADAR ECHOES IN OKLAHOMA J. T. Lee p 1-9 refs

(See N67-31663 18-20)

2. SOME PHYSICAL AND DYNAMICAL ASPECTS OF A SEVERE RIGHT-MOVING CUMULONIMBUS J. C. Frankhauser p 11–32 refs (See N67-31664 18-20)

N67-31663# National Severe Storms Lab., Norman, Okla.
ASSOCIATION BETWEEN ATMOSPHERIC TURBULENCE AND RADAR ECHOES IN OKLAHOMA
J. T. Lee *In its* Thunderstorm Circulations and Turbulence Studies from Aircraft and Radar Data Apr. 1967 p 1–9 refs (See N67-31602 18-20)

Turbulence experienced by aircraft during penetration of Oklahoma thunderstorms is compared with the characteristics of associated radar echoes. The correlation coefficient between the standard deviation of the derived gust velocity and the maximum radar reflectivity of the penetrated storm is about .55, according to data collected during 87 storm flights made by a USAF F-100 aircraft during 1964 and 1965. The correlation between the standard deviation and radar reflectivity gradient is less than 0.3. Other characteristics of the radar echo such as maximum reflectivity gradient, maximum reflectivity along flight path, and average gradient of reflectivity along the flight path are investigated, but are not found to contribute appreciably to the estimation of turbulence. At present, the maximum radar reflectivity of a storm seems to be the best indicator of turbulence encountered by an aircraft. The data show a lower frequency of severe turbulence at 37,000 feet altitude than at 27,000 feet, though the incidence of weaker categories is about the same. Author

N67-31664# National Severe Storms Lab., Norman, Okla.
SOME PHYSICAL AND DYNAMICAL ASPECTS OF A SEVERE RIGHT-MOVING CUMULONIMBUS
James C. Frankhauser *In its* Thunderstorm Circulations and Turbulence Studies from Aircraft and Radar Data Apr. 1967 p 11–32 refs (See N67-31602 18-20)

The morphology and dynamics of an isolated severe thunderstorm are analyzed and interpreted using observations obtained by instrumented aircraft and radar. Several aspects of the Severe-flight (SR) quasi-steady-state thunderstorm model proposed by Browning are supported by features of the storm's motion pattern, RHI radar profiles, and by certain kinematic properties. Net cyclonic circulation measured near the cloud base is considered as a mechanism for steering the storm. Comparison of rainfall with low-level moisture convergence reveals that about 60% of the intercepted water vapor is deposited on the ground during the storm's persistent phase. Author

N67-31714# National Severe Storms Lab., Norman, Okla.
STUDY OF A LEFT MOVING THUNDERSTORM OF 23 APRIL 1964
George R. Hammond Apr. 1967 88 p refs
(IERTM-NSSL-31)

On 23 April 1964 a thunderstorm moved rapidly northeastward across central Oklahoma. Its movement was to the left of all winds in the middle and upper troposphere and it produced hail as large as 3-1/2 in. in diameter, one known tornado, and surface winds up to 53 knots. Synoptic charts reveal that the storm was an isolated airmass. Mesonetwork data show that a gust front extended westward from the left flank of the radar echo of the storm. A cold cell and mesohigh beneath the storm kept the same orientation with respect to the radar echo and the gust front. Radar analysis reveals that the path of the storm deviated up to 40° to the left of the mean tropospheric wind. Its speed was up to 40 knots, the mean tropospheric wind speed was 31 knots. Proposed is a quasi-steady state model of the storm which is a mirror image of the Browning–Ludlam model of a right moving storm. Environmental conditions in the study were identical with those of right moving storms. The characteristic organization and structure of the storm was probably caused by the orientation of the winds relative to it. It is concluded that the same environmental wind field can account for organization and structure of either right or left moving storms, depending on storm velocity. K.W.

N67-31829# Travelers Research Center, Inc., Hartford, Conn.
RESEARCH ON THE THEORY OF CLIMATE Final Report, 1 Apr. 1966–31 Mar. 1967
Barry Saltzman Mar. 1967 86 p refs
(Contract CWB-11389)
(Rept.-7045-249)

CONTENTS:

1. STEADY STATE SOLUTIONS FOR AXIALLY-SYMMETRIC CLIMATIC VARIABLES Barry Saltzmann p 1–38 refs

2. EQUATIONS FOR GLOBAL MONSOONS AND TOROIDAL CIRCULATIONS IN THE σ-COORDINATE SYSTEM M. S. Rao (Council of Sci. and Ind. Res.) p 39–70 refs (See N67-31830 18-20)

3. A METHOD OF SOLUTION FOR A SYSTEM OF TWO SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS ARISING IN THE THEORY OF THE MEAN ATMOSPHERIC WAVES M. Sankar-Rao (Council of Sci. and Ind. Res.) p 71–79 refs (See N67-31831 18-13)

N67-31830# Travelers Research Center, Inc., Hartford, Conn.
EQUATIONS FOR GLOBAL MONSOONS AND TOROIDAL CIRCULATIONS IN THE σ-COORDINATE SYSTEM
M. Sankar Rao (Council of Sci. and Ind. Res.) *In its* Res. on the Theory of Climate Mar. 1967 p 39–70 refs (See N67-31829 18-20)

In a coordinate system in which the ground is always a coordinate surface, climatic equations for axially asymmetric and symmetric atmospheric motions are derived. These are compared with their counterparts in the pressure coordinate system. Some qualitative predictions regarding solutions are given. Author

N67-31861 Joint Publications Research Service, Washington, D. C.
AUTOMATIC COMPILATION OF CLOUD MAPS ON THE SETUN' ELECTRONIC COMPUTER USING WEATHER SATELLITE DATA
N. M. Potiyevskiy and N. I. Rumyantsev 7 Jun. 1967 5 p Transl. into ENGLISH from Tr. Tsentr. Inst. Prognozov (Moscow), no. 152, 1966 p 25–28
(JPRS-41294; TT-67-31934) CFSTI: $3.00

A Setun' electronic computer was used to plot cloud information provided by Tiros-type weather satellites. Ordinary telegraph punch tape loads information into the computer, and processing takes between one and two minutes. A computer-printed cloud map is illustrated. M.W.R.

N67-32488 Joint Publications Research Service, Washington, D. C.
APPLICATION OF ELECTRONIC COMPUTERS IN WEATHER FORECASTING
Ling-lu Chi 1 Mar. 1967 18 p Transl. into ENGLISH from Tien-Tzu Chi-Shu (Shanghai), no. 10, Oct. 1966 p 36–37
(JPRS-40069; TT-67-30718) CFSTI: HC $3.00

China's computer technology and some of its applications are briefly discussed. The construction of a computer program for northern hemisphere weather prediction is described. R.N.A.

N67-32462# Texas A&M Univ., College Station. Dept. of Oceanography.
AN APPROACH TO THE ANALYSIS OF SEA SURFACE TEMPERATURE DATA FOR UTILIZATION IN HURRICANE FORECASTING IN THE GULF OF MEXICO
James Glenn Taylor (Environ. Sci. Ser. Admin.) Oct. 1966 106 p refs *Its* Reference 66-25T
(Contract Nonr-2119(04))

Sea surface temperature (SST) patterns have been analyzed for four major hurricanes in the Gulf of Mexico in an effort to determine if routinely available SST data might be more fully utilized as an aid to the hurricane forecaster. SST data reported by merchant vessels are the primary data used in this study. Mean daily SST charts were prepared for approximately ten to twelve days prior to the time when each hurricane moved inland. Also, a series of 3-day, 5-day, and 7-day mean SST charts were prepared for Hurricane Hilda. The SST charts for Hurricanes Audrey, Carla, and Hilda were plotted and analyzed with the point of hurricane landfall known. In an attempt to stimulate realistic conditions and to insure an objective analysis, a series of daily mean SST charts for Hurricane Betsy were plotted while the storm was in progress. The conservative nature of ocean temperature is discussed, and it is stressed that a great amount of energy is required to make a significant change. It is pointed out that the SST data used are taken at varying depths in the first few meters below the surface, and that the values obtained are not necessarily the same as surface temperatures measured by radiation devices. It is suggested that even though there are obvious limitations to available SST data, it is possible that the data might be more fully utilized as an aid to the hurricane forecaster. Author (TAB)

N67-32487# American Meteorological Society, Boston, Mass.
CHARACTERISTICS OF FRONTAL CLOUDS SUSCEPTIBLE TO MODIFICATION OF NATURAL PRECIPITATION [KHARAKTERISTIKI FRONTAL'NYKH OBLAKOV PRIGODNYKH DLIA INTENSIFIKATSII ESTESTVENNYKH OSADKOV]
I. N. Ponomarenko, A. M. Koshenko, and T. N. Zabolotskaia Bedford, Mass. AFCRL, Apr. 1967 17 p refs Transl. into ENGLISH from Tr. Ukr. Nauchn.-Issled. Gidrometeorol. Inst. (Kiev), no. 47, 1965 p 79–87
Contract AF 19(628)-3880)
(T-R-528; TT-67-62075; AD-653171) CFSTI: HC $3.00/MF $0.65

Data are given on the phase composition of clouds in frontal zones over the Ukraine and the characteristics of frontal cloud systems susceptible to artificial initiation of precipitation. TAB

N67-32510*# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
INVESTIGATION OF WARM FOG PROPERTIES AND FOG MODIFICATION CONCEPTS Quarterly Progress Report
Warren C. Kocmond and James E. Jiusto 15 Jul. 1967 24 p
(Contract NASr-156)
(NASA-CR-86666; CAL-RM-1788-P-16) CFSTI: HC $3.00/MF $0.65 CSCL 04B

Analytical studies were conducted on warm fog properties and possible fog modification methods. Visibility improvements achieved in laboratory fog seeding experiments are summarized. Three types of seeding experiments were conducted: preseeding the atmosphere with NaCl nuclei to inhibit the formation of dense natural fog, seeding an atmosphere in which fog had already formed but was dissipating, and seeding an atmosphere in which a persistent fog had formed. Results obtained from seeding existing fogs are presented, and tentative conclusions are formulated. Laboratory experiments indicated that a zone 2 kilometers long, 500 meters wide, and 100 meters high might be opened for landings with 200 to 400 kilograms of NaCl nuclei having the proper sized distribution. S.P.

N67-32516# Texas A&M Univ., College Station. Dept. of Oceanography.
SYNOPTIC ANALYSIS OF NEAR SURFACE AND SUBSURFACE TEMPERATURES IN THE ATLANTIC OCEAN FOLLOWING HURRICANE BETSY
Robert C. Landis Dec. 1966 48 p refs *Its* Reference 66-30-T
(Contract Nonr-2119(04))
(AD-653270) CFSTI: HC $3.00/MF $0.65

Data from sea surface temperature and bathythermograph radio messages are utilized in analyzing the thermal change in the Atlantic Ocean during the passage of Hurricane Betsy, 1965. Seven-day average sea surface temperature patterns show changes of 4 F in the wake of the hurricane, where upwelling is shown to have taken place. Two temperature sections based on observations made before and after the storm passage are composed across the hurricane path. The first temperature section, taken one week after storm passage, indicates upwelling from the depth of 200 feet. The second section, representing three weeks after storm passage, shows upwelling to have occurred but because of the time lag between storm passage and BT observation, much of this area has mixed and has been advected slightly to the north. In addition, the second section clearly shows an area of downwelling. Magnitudes of the thermal changes are shown by computations of the change in heat content for a square centimeter column of water. Results of the analyses compare favorably to previous studies based on research data and may be of use to the oceanographic forecaster. Author (TAB)

N67-32549# RAND Corp., Santa Monica, Calif.
NUMERICAL SIMULATION OF CUMULUS CONVECTION
F. W. Murray Apr. 1967 41 p refs
(Contract N0014-67-C-0101)
(RM-5316-NRL; AD-652812) CFSTI: HC $3.00/MF $0.65

Atmospheric thermal convection, including condensation and evaporation, is modeled on the cumulus scale by numerically solving the equations of hydrodynamics and thermodynamics. Appropriate finite-difference equations are derived for both axial and rectilinear symmetry and for two differencing schemes. A mixed Euler-Lagrange method is used. A specific example is discussed, and its computational results are compared with observations made from instrumented aircraft of the Naval Research Laboratory. It is concluded that the model is realistic in many respects, and that it could be a useful adjunct for research in cloud dynamics and cloud physics, particularly in the field of weather modification. Author (TAB)

N67-32573# Army Electronics Research and Development Activity, Fort Huachuca, Ariz.
THE DISTRIBUTION OF EDDY VELOCITIES AND TEMPERATURE FLUCTUATIONS IN THE FIRST 100 METERS
Thomas H. Pries and James F. Appleby May 1967 67 p refs
(ECOM-6027; AD-653016) CFSTI: HC $3.00/MF $0.65

Practical problems dealing with atmospheric turbulence can be simplified by relating fluctuation values to a Gaussian distribution. This is very useful, since it specifies characteristics of the eddy velocity distributions. Fragmentary studies have given some evidence to support the Gaussian hypothesis, but to our knowledge this is the first attempt to examine the distributions of the fluctuation components for a large data sample (135 one-hour runs). The purpose of the study is to determine the deviations of the observed distribution from a normal distribution and to attempt to determine if these departures can be related to atmospheric stability surface roughness, and height above the surface. In addition, each sample was tested to determine the probability of its coming from a normal distribution. Results are in general agreement with previous investigations. Low frequency trends over hour periods tend to increase the departures from a normal distribution. Treating the probability distributions of the wind components as being normally

distributed appears justified over moderate ranges of stability (z/L between -.300 and +.300). Author (TAB)

N67-32697# American Meteorological Society, Boston, Mass.
CONCERNING THE ORIGIN OF A THIN, ELEVATED, NOCTURNAL FOG LAYER [K VOPROSU O ZAROZHDENII TONKOGO SLOIA PRIPODNIATOGO NOCHNOGO TUMANA]
L. Z. Prokh and L. M. Roev Bedford, Mass., AFCRL, Apr. 1967 10 p refs Transl. into ENGLISH from Tr. Ukr. Nauchnoissled. Gidrometeorol. Inst. (Kiev), no. 48, 1965 p 96–100
(Contract AF 19(628)-3880)
(T-R-563; TT-67-62070; AD-653166) CFSTI: HC $3.00/MF $0.65

The heat balance equations of a turbid isothermal layer of air warmer than the ground provided a criterion for calculating the rate of temperature change within this layer under specified conditions. TAB

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-32090*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
CONCEPTUAL MECHANIZATION STUDIES FOR A HORIZON DEFINITION SPACECRAFT ATTITUDE CONTROL SUBSYSTEM, PHASE A, PART II, 10 OCTOBER 1966–29 MAY 1967
Norris W. Tidwell, Calvin G. Senechal, Eldon L. Tesch, Howard A. Knudtson, Jr., and David J. Hartman May 1967 140 p refs
(Contract NAS1-6010)
(NASA-CR-66382) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A feasible attitude control subsystem concept utilizing magnetic torquing and ground commanding was developed for the Horizon Definition Study spacecraft. A V-head sensor operating in the 14- to 16-micron infrared region will be used for coarse attitude sensing. The spin rate of the spacecraft will be maintained at three rpm. Orbital regression will be compensated for by magnetic torquing coils. Author

N67-32216*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
VERY LOW FREQUENCY PROPAGATION
J. A. Pierce *In its* Cruft Lab. Mar. 1967 8 p (See N67-32215 18-34)

The phase of a modulation frequency was measured. A suitable signal at 226 2/3 c/s was transmitted from Trinidad for several months. This signal appears as phase modulation of a carrier at 13.6 kc/s. The modulation index is extremely low, about 0.15, because of the high Q of the tuning system in the transmitting system. Plots for the diurnal average and standard deviation for a series of measurements over eight days in July, and for a longer run made soon after, are compared. In the second plot there is no great change in the mean curve, but the standard deviation is near 50 μs. This large level and the general uniformity throughout the day suggest that the primary variation is not, in fact, diurnal. To check this hypothesis, the data (corrected for the mean diurnal variation) were plotted as a function of other received data, and it is seen that the received phase wanders relatively slowly throughout a range of ≤100 microseconds. The quasi-period of several days seems to suggest that the cause may be variations in magnetic activity. Other data regarding the oscillation frequency of the absolute phase system of Omega (described previously) are also discussed. L.S.

N67-32486*# Montana State Coll., Bozeman.
A THEORY OF MANUAL SPACE NAVIGATION
Kenneth Nordtvedt, Jr. Washington, NASA, Jul. 1967 83 p refs
(Grant NGR-27-001-015)
(NASA-CR-841) CFSTI: HC $3.00/MF $0.65 CSCL 17G

A set of space navigation equations which are exact equations, yet are linear equations, is developed. This makes them particularly suited to manual space navigation applications. The linearity of the equations leads to simple methods for incorporating redundant observations into the orbit parameter estimation equations. Navigation accuracy and other operational aspects of a proposed manual space navigation system are studied. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-31694# Atomics International, Canoga Park, Calif.
COMPARISON OF PREDICTED AND MEASURED LAUNCH LOADS FOR SNAP 10A
Everett A. Robb and A. P. Gelman *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 73–78 (See N67-31688 18-32)
(Contract AT(11-1)-GEN-8)

The development of structural design criteria for SNAP 10A is discussed. The vibration-induced lateral bending moments critical for the SNAP 10A support structure are emphasized. The predicted loads used in design and testing of the satellite are compared with the actual loads encountered in flight. Author

N67-31702# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
THE IRRADIATION BEHAVIOR OF UO_2–PuO_2 FUELS IN PRTR
M. D. Freshley and F. E. Panisko Mar. 1967 27 p refs
(Contract AT(45-1)-1830)
(BNWL-366) CFSTI: HC $3.00/MF $0.65

The irradiation behavior of full-sized, UO_2–PuO_2 fuel elements was investigated under power reactor conditions in the Plutonium Recycle Test Reactor (PRTR) at Pacific Northwest Laboratory to obtain information related to Pu utilization in thermal reactors. Vibrationally compacted UO_2–PuO_2 fuel structures change significantly when irradiated at rod powers of 20 kW/ft with centerline fuel temperatures near melting. The major changes in fuel structure occurred rapidly; whereas, time-temperature dependent sintering effects caused the fuel sintering radius to increase with exposure. In reactor homogenization and solid-solution formation by UO_2 and PuO_2 interdiffusion commenced in pneumatically impacted, physically mixed UO_2–PuO_2 fuel at temperatures sufficient to cause sintering. Fuel melting, as evidenced by the formation of a well-defined region composed of a cellular appearing structure in the thermal center of the rod, commenced in vibrationally compacted (86% TD) UO_2–2 wt % PuO_2 fuel rods at 20 to 21 kW/ft under PRTR operating conditions. The results show that the

power to produce melting in vibrationally compacted fuel is ≈20% less than for sintered pellet fuel. NSA

N67-31717# Mound Lab., Miamisburg, Ohio.
REACTOR FUELS AND MATERIALS DEVELOPMENT. PLUTONIUM RESEARCH Quarterly Progress Report, Jan.–Mar. 1966
7 Apr. 1967 34 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1346) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: Pu–U–Zr ternary system; grain boundary relaxation in α U; heat capacity of δ' Pu; densities of liquid Pu–Ce alloys; viscosities of liquid Au, Pb, and U; and Pu–O systems. NSA

N67-31741# National Lead Co. of Ohio, Cincinnati. Feed Materials Production Center.
ROLLING STUDIES OF URANIUM RODS AND TUBES
H. W. Hesselbrock Apr. 1967 35 p refs
(Contract AT(30-1)-1156)
(NLCO-990) CFSTI: HC $3.00/MF $0.65

Uranium billets, both hollow and solid, were rolled on a 16- by 24-inch two-high mill. Three types of uranium were studied: unalloyed metal; metal with 100 to 150 ppm iron and silicon; and metal with 350 ppm iron, 350 ppm silicon, and 800 ppm aluminum. Roll separating forces, dimensional changes, and grain structures were evaluated for varying amounts of working. The change in wall thickness during rolling was ascertained for billets of varying T/D ratios (initial wall thickness to diameter). Wall thicknesses ranging from 10% of the OD to a solid bar were explored. The ratio of the separation forces of rods to tubes was determined.

N67-31804# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
INFRARED DETECTION OF NUCLEAR REACTOR COOLANT IMPURITIES Interim Report
B. B. Brenden, W. J. Coleman, G. E. Moore, and W. G. Spear Feb. 1967 18 p refs
(Contract AT(45-1)-1830)
(BNWL-377) CFSTI: HC $3.00/MF $0.65

An experimental absorption hygrometer was developed to measure the water vapor content in a flowing stream of gas. The indicated accuracy of the instrument, in terms of dew point, is ±2°F over a range of dew points from −46°F to +56°F. To facilitate appropriate calibration of the hygrometer, a variable pressure saturator was developed and utilized. Based upon extensive tests of initial hygrometer, the development and fabrication of a second generation system, termed Mark II, were undertaken with the expectation of improved accuracy and reliability. Author (NSA)

N67-31901# Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY THROUGH SEPTEMBER, 1966
Donald L. Keller 1 Oct. 1966 58 p refs
(Contract W-7405-ENG-92)
(BMI-1784) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. URANIUM–PLUTONIUM MONONITRIDE FUEL MATERIALS (AEC-DRD) W. M. Pardue et al 21 p refs (See N67-31902 18-22)

2. IRRADIATION EFFECTS IN REACTOR CLADDING MATERIALS (AEC-DRD) F. R. Shober et al 8 p (See N67-31903 18-22)

3. COATED-PARTICLE FUEL MATERIALS (AEC-DRD) W. F. Pfeifer et al 12 p (See N67-31904 18-22)

4. DEVELOPMENT OF FUELS FOR GAS-COOLED REACTORS (AEC-DRD) V. W. Storhok et al 2 p (See N67-31905 18-22)

5. UO_2–PuO_2 FUEL DEVELOPMENT (GA) D. F. Askey and W. M. Pardue 2 p (See N67-31906 18-22)

6. EFFECTS OF HIGH BURNUP ON UO_2–CeO_2 AND UO_2–ZrO_2 FUELS (CE) E. Fromm, J. W. Ray, J. H. Saling, V. W. Storhok, and J. E. Gates 3 p (See N67-31907 18-22)

N67-31902# Battelle Memorial Inst., Columbus, Ohio.
URANIUM–PLUTONIUM MONONITRIDE FUEL MATERIALS (AEC-DRD)
W. M. Pardue et al *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 21 p refs (See N67-31901 18-22)

These studies are being conducted to evaluate the potential of mixed uranium–plutonium mononitride fuels for fast breeder applications. Emphasis is being placed on the uranium–plutonium nitrides, although the synthesis and fabrication of uranium–plutonium carbonitrides are being studied. The studies include fabrication of the nitride fuels and evaluation of their potential by measurements of vaporization kinetics and thermodynamics, and thermal stability, conductivity, and expansion; fabrication of irradiation specimens; evaluation of the irradiated fuel; and technical consideration of various questions that arise in the conduct of the program. Author

N67-31903# Battelle Memorial Inst., Columbus, Ohio.
IRRADIATION EFFECTS IN REACTOR CLADDING MATERIALS (AEC-DRD)
F. R. Shober et al *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 8 p (See N67-31901 18-22)

Studies to determine irradiation-induced changes in the mechanical properties of stainless steel and other potential cladding materials for liquid-metal-cooled fast reactor applications are reported. The main experimental effort was directed toward investigation of the low ductility exhibited by stainless steel at 750°C. The typical elongated dimples characteristic of transgranular ductile fractures and the grain-boundary facets indicating intergranular fracture are illustrated for a stainless steel specimen. A program to evaluate the long-time heat treatments at 800, 1000, and 1200°F on selected properties of stainless steel is described. Results for room temperature tensile testing of stainless steel in the as-received and heat-treated conditions are tabulated. S.P.

N67-31904# Battelle Memorial Inst., Columbus, Ohio.
COATED-PARTICLE FUEL MATERIALS (AEC-DRD)
W. F. Pfeifer et al *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 12 p (See N67-31901 18-22)

Characteristics of various coated-particle fuel materials are determined. Emphasis is directed toward the development of ceramic-coated uranium nitride and plutonium-base particle fuels for broad, general utilization. The primary objective is to achieve satisfactory resistance to radiation damage, thermal shock, and chemical interactions, using the thinnest possible coatings. The studies include fuel-particle preparation and characterization, coating deposition and characterization, coating-fuel compatibility studies, irradiation studies, and fission-product-release studies. In addition, new techniques for depositing coatings of graphite are investigated. Author

N67-31905# Battelle Memorial Inst., Columbus, Ohio.
DEVELOPMENT OF FUELS FOR GAS-COOLED REACTORS (AEC-DRD)

V. W. Storhok et al *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 2 p (See N67-31901 18-22)

Studies to provide fuel-materials support to gas-cooled reactor concepts are presented. Efforts have been devoted to determination of the potential of BeO–ThO_2–PuO_2 dispersion fuels for applications in EBOR-type reactors. Investigations of out-of-pile properties and development of fabrication techniques to produce bodies with optimum structures are described. Upon completion of these studies, emphasis is expected to shift toward the development of uranium–plutonium fuels for gas-cooled fast-breeder-reactor applications. Author

N67-31906# Battelle Memorial Inst., Columbus, Ohio.
UO_2–PuO_2 FUEL DEVELOPMENT (GA)
D. F. Askey and W. M. Pardue *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 2 p (See N67-31901 18-22)

Efforts to fabricate, characterize, and encapsulate mixed UO_2–PuO_2 fuel pellets for irradiation studies are described. Mixed oxide fuel pellets are prepared by cold compaction and sintering and then assembled into finished irradiation specimens using cladding components. The pellets and fuel-rod assemblies are characterized before irradiation by dimensional, radiographic, metallographic, and analytical chemistry techniques. S.P.

N67-31907# Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF HIGH BURNUP ON UO_2–CeO_2 AND UO_2–ZrO_2 FUELS (CE)
E. O. Fromm, J. W. Ray, J. H. Saling, V. W. Storhok, and J. E. Gates *In its* Prog. Relating to Civilian Appl. during Jul. through Sep. 1966 1 Oct. 1966 3 p (See N67-31901 18-22)

Studies to determine the radiation stability of stainless steel-clad solid-solution ceramic fuels after fuel fission burnups are described. The fuels are UO_2–CeO_2 and UO_2–ZrO_2. Important target irradiation conditions for six thermocoupled capsules are summarized. Irradiation data and corrected burnup and fission-gas release data are tabulated. Metallographic examinations, X-ray diffraction analyses, and autoradiographing of selected samples are also described. S.P.

N67-32106# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
REACTION OF MOLTEN UO_2 WITH WATER
R. L. Gibby Jan. 1967 10 p refs
(Contract AT(45-1)-1830)
(BNWL-362) CFSTI: HC $3.00/MF $0.65

The results of the investigation of fused UO_2 reactions with water at various temperatures are presented. H_2 generation is measured and oxidation products determined. NSA

N67-32111*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN AEROSPACE NUCLEAR SAFETY ANALYSIS OF A PM_2O_3 RADIOISOJET THRUSTER
William S. West, Andrew J. Parker, Jr., and David W. Pyatt (Hittman Associates, Inc.) Jun. 1967 41 p refs Prepared jointly with Hittman Associates, Inc.
(Contract NAS5-10235)
(NASA-TM-X-55844; X-701-67-279) CFSTI: HC $3.00/MF $0.65 CSCL 18E

A nuclear thruster known as the Radioisojet (RIJ) is used to demonstrate the application of a nuclear heat source and its suitability to meet aerospace nuclear safety criteria when incorporated into a pulse jet thruster design. The atmospheric reentry analysis considers the oxidation and ablation of refractory metals. The parking orbit situation was chosen for the study as the energy levels experienced by the RIJ from a parking orbit decay would present a worst case nuclear safety hazard. A scoping analysis was performed to define the RIJ launch vehicle, mission type, and abort environment. Based on the results of this analysis a detailed investigation was performed to evaluate the potential of the radioisojet fuel capsule to reenter the earth's atmosphere and/or burn up. S.P.

N67-32335*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CALCULATION OF FAST-NEUTRON FLUX EMERGING FROM A REACTOR BEAMHOLE AND COMPARISON WITH EXPERIMENT
Harvey S. Bloomfield Washington, NASA, Aug. 1967 18 p refs
(NASA-TM-X-1418) CFSTI: HC $3.00/MF $0.65 CSCL 18K

A comparison of calculated and measured fast-neutron fluxes emerging from the HB-6 beamhole of the NASA Plum Brook reactor is presented. Integrated dose rates were calculated with the QAD line-of-sight computer program using Albert–Welton removal theory to account for neutron attenuation. The program output was converted to fast flux with the Snyder–Neufeld conversion factors and then modified by the use of collimated removal cross sections to account for the reduction of the scattered flux component emerging from the duct. In addition, the use of neutron removal theory in nonhydrogenous media was assumed valid because of recent measurements. Measured flux values were calculated from sulfur foil activation data and then extrapolated to a lower energy of 0.3 MeV (0.048 picojoule) to correspond to the conventional energy range of the calculational method. The extrapolation was carried out by using both a fission spectrum and a beryllium altered fission spectrum. These spectra were chosen to represent the possible extremes of the true duct spectrum, which was estimated to be a hardened fission spectrum. Results of the comparison indicate that the calculational method can predict fast-neutron fluxes emerging from the HB-6 beamhole to within a factor of about 1.5 when suitable corrections to the method are applied. Author

N67-32354# Battelle Memorial Inst., Columbus, Ohio.
PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER THROUGH DECEMBER, 1966
Donald L. Keller 1 Jan. 1967 92 p refs
(Contract W-7405-ENG-92)
(BMI-1791) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. URANIUM–PLUTONIUM MONONITRIDE FUEL MATERIALS (AEC-DRD) W. M. Pardue and F. A. Rough 41 p refs (See N67-32355 18-22)

2. IRRADIATION EFFECTS IN REACTOR CLADDING MATERIALS (AEC-DRD) F. R. Shober 13 p (See N67-32356 18-22)

3. COATED-PARTICLE FUEL MATERIALS (AEC-DRD) W. H. Pfeifer, N. E. Miller, and C. W. Townley 18 p (See N67-32357 18-22)

4. UO_2–PuO_2 FUEL DEVELOPMENT (GA) M. D. Houston and W. M. Pardue 7 p refs (See N67-32358 18-22)

5. EFFECTS OF HIGH BURNUP ON UO_2–CeO_2 AND UO_2–ZrO_2 FUELS (CE) E. O. Fromm, J. W. Ray, J. H. Saling, V. W. Storhok, and J. E. Gates 4 p (See N67-32359 18-22)

N67-32355# Battelle Memorial Inst., Columbus, Ohio.
URANIUM–PLUTONIUM MONONITRIDE FUEL MATERIALS (AEC-DRD)

W. M. Pardue and F. A. Rough *In its* Progr. Relating to Civilian Appl. during Oct. through Dec., 1966 1 Jan. 1967 41 p refs (See N67-32354 18-22)

Studies are being conducted to evaluate the potential of mixed UN–PuN fuels for use in liquid metal fast breeder reactors. The synthesis and fabrication of uranium–plutonium carbonitrides are also being studied. Efforts on the preparation of these materials, property determinations, irradiation studies, and supporting studies are discussed in detail. Nitride materials are being prepared by gas–solid reactions, melting of the constituents, and by carbothermic reduction of the uranium–plutonium oxides. Physical properties of importance for reactor design are being determined, including volatility tendencies, conductivity, expansivity, and chemical stability of the fuels in contact with potential liquid metal fast breeder reactor cladding materials. The radiation resistance of the nitride fuels is being determined to evaluate their suitability to long-term irradiation environments. R.N.A.

N67-32356# Battelle Memorial Inst., Columbus, Ohio.
IRRADIATION EFFECTS IN REACTOR CLADDING MATERIALS (AEC-DRD)
F. R. Shober *In its* Progr. Relating to Civilian Appl. during Oct. through Dec., 1966 1 Jan. 1967 13 p (See N67-32354 18-22)

An experimental program is being conducted to determine the effect of irradiation on the mechanical properties of various reactor cladding materials and to investigate the long term thermostability of Type 347 stainless steel. Efforts on these two studies during this period are discussed. A brief review of the approaches being used and past results is included. R.N.A.

N67-32357# Battelle Memorial Inst., Columbus, Ohio.
COATED-PARTICLE FUEL MATERIALS (AEC-DRD)
W. H. Pfeifer, N. E. Miller, and C. W. Townley *In its* Progr. Relating to Civilian Appl. during Oct. through Dec., 1966 1 Jan. 1967 18 p (See N67-32354 18-22)

The characteristics of various coated particle reactor fuel materials are being investigated to produce materials which are resistant to radiation damage, thermal shock, and chemical interactions, using the thinnest possible coatings. Progress during this period was concerned with efforts to produce and characterize ceramic coated plutonium-base particle fuels, and the feasibility of coating fuel particles with graphite by precipitation from liquid metal solutions. A brief description of the approaches being used and previously reported results are included. R.N.A.

N67-32358# Battelle Memorial Inst., Columbus, Ohio.
UO_2–PuO_2 FUEL DEVELOPMENT (GA)
M. D. Houston and W. M. Pardue *In its* Progr. Relating to Civilian Appl. during Oct. through Dec., 1966 1 Jan. 1967 7 p refs (See N67-32354 18-22)

Progress is reported on the development of mixed UO_2–PuO_2 fuel elements for use in gas cooled fast reactor irradiation experiments. During this period processing parameters for preparing pellets of 90% of theoretical density were established. Enough pellets were made to load three fuel elements and the first of four capsules was assembled from these elements. R.N.A.

N67-32359# Battelle Memorial Inst., Columbus, Ohio.
EFFECTS OF HIGH BURNUP ON UO_2–CeO_2 AND UO_2–ZrO_2 FUELS (CE)
E. O. Fromm, J. W. Ray, J. H. Saling, V. W. Storhok, and J. E. Geise *In its* Progr. Relating to Civilian Appl. During Oct. through Dec. 1966 1 Jan. 1967 4 p (See N67-32354 18-22)

A study is being made of homogeneous ceramic reactor fuels by irradiating specimens to burnups up to 26×10^{20} fissions per cm^3 with cladding surface and fuel center line temperatures of about 600° and 4000°F, respectively, and by examining the irradiated specimens. Postirradiation examinations were conducted during this period on three of the stainless steel clad ceramic fuel capsules by neutron radiography, gamma scanning, fission gas analysis, and X-ray diffraction analysis. R.N.A.

N67-32371*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND PERFORMANCE OF A NUCLEAR REACTOR SIMULATOR FOR NONNUCLEAR TESTING OF SPACE POWER SYSTEMS
Kent S. Jeff Washington, NASA, Aug. 1967 35 p refs
(NASA-TN-D-4095) CFSTI: HC$3.00/MF$0.65 CSCL 18M

A SNAP-8 reactor simulator consisting primarily of an electric heater and an analog computer was designed and tested. The simulation method was to represent three distinct subdivisions of the reactor dynamics independently. An electric heater represented reactor thermodynamics; an analog computer simulated both reactor nucleonics and reactor control. A digital-computer model of the SNAP-8 reactor was used to evaluate the performance of the reactor simulator. This computer model was shown to agree approximately with the limited amount of SNAP-8 reactor data available. When both the simulator and the digital-computer model were perturbed by the same slow change of reactor coolant inlet temperature, good agreement was observed. However when both systems were perturbed by the same step change of coolant flow the simulator responded more slowly than the digital-computer model. This effect was attributed to the particular heater used, which had too large a thermal mass to simulate SNAP-8 reactor thermodynamics accurately. This heater was used in the simulation because the original, faster responding heater failed electrically. Author

N67-32404# Atomic Energy Commission, Washington, D. C. Div. of Reactor Development and Technology.
INTERNATIONAL SYMPOSIUM ON DEVELOPMENTS IN IRRADIATION CAPSULE TECHNOLOGY
Donna R. Hoffman, ed. Mar. 1967 1032 p refs Proc. of the Joint AEC/GE Meeting, held in Pleasanton, Calif., 3–5 May 1966
(Conf-660511) CFSTI: HC$3.00/MF$0.65

Papers on capsule designs and operation with non-fissile and fissile materials, binary gas temperature control, repositioning power control, circulating liquid metal experiments, spectral control and dosimetry techniques, instrumentation and data reduction, and general test reactor activities are presented. For individual titles see N67-32405–N67-32458.

N67-32405# General Electric Co., San Jose, Calif. Nuclear Technology Dept.
TENSILE COUPON IRRADIATION TECHNIQUE
D. H. Coplin, M. F. Lyons, T. J. Pashos, and B. Weidenbaum *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 6 p refs (See N67-32404 18-22)
(Contract AT(04-3)-189)

An irradiation technique was devised to obtain high levels of neutron exposures in fuel rod clad materials by utilizing space on an existing irradiation experiment. The UO_2 high performance program had been using the pressurized water loop of the test reactor to obtain information on the functional limits of operating UO_2 with gross central melting. The assembly consisted of four shroud tubes; each shroud tube contained a fuel rod under test. A recommendation was made to attach tensile coupons to the fuel assembly in the space between the shroud tubes and thereby obtain irradiation effects information on several cladding materials without incurring additional irradiation costs. The accumulated

exposures for the samples were determined by both physics analysis for the reactor position and the materials involved, and by chemical activation analysis of sections of the hold-down rods. The hold-down rods were scanned for gamma activity and the relative gamma activities for the positions of the coupons were used to estimate the accumulated neutron exposure for each sample. Author

N67-32406# Commissariat a l'Energie Atomique, Grenoble (France).
IRRADIATION RIGS—POSSIBILITIES OF STANDARDISATION
P. Millies *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 74 p (See N67-32404 18-22)

The widely differing techniques involved in rig design and fabrication are discussed in relation to the specific requirements imposed by experimental conditions in the reactor, and to certain imperatives determined by the reactor itself. Based on experience, it is considered possible to fix ranges within which experimental conditions are contained, e.g., the temperatures of sheath and structural materials are usually between 150° and 900°C; sample shape and size are defined by existing laboratory equipment; and thermal energy of nuclear origin is determined by the reactor, the flux of which is known. The point is made that if standard rigs can be designed for experimental conditions within each range, series production is possible. Two conditions for standardization are stipulated: separation of samples from rig, and maximum distributed control power. Descriptive data are provided on six standardized rigs, with details given on operating principles and applications. M.G.J.

N67-32407# General Electric Co., San Jose, Calif. Atomic Products Div.
UNIQUE PROBLEMS AND SOLUTIONS ON GETR MATERIALS IRRADIATION CAPSULES—STRAIN CYCLE NUMBER 10 & 11
R. P. Morissette and S. Y. Ogawa *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 8 p refs (See N67-32404 18-22)
(Contract AT(04-3)-189)

Novel solutions are proposed to three design problems on strain cycle capsule #10 which was designed for operation in the test reactor to irradiate candidate superheat fuel-rod cladding materials at elevated temperatures. The materials included Incoloy 800, 625, and 825, and Hastelloy X. Temperature variation across various gas gaps is considered, with a stepped design chosen for ease of machining. Requirements for the burst specimen are stated, and the final design is depicted. The entire assembly is connected to a high pressure fitting which in turn is connected to a high pressure system. An aluminum coating was applied to soldered joints of the capsule; post-irradiation examination, however, showed it to be unsatisfactory. Also discussed is a proposed capsule design for in-reactor strain cycling experiments on the behavior of superheat cladding materials. M.G.J.

N67-32408# Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium).
STEEL IRRADIATION CAPSULE AND RIG
W. R. Ruston, G. de Meere, J. Muylaert, G. Becriau, Y. Seki (Mitsubishi Atomic Power Ind., Inc., Ohmiya City, Japan), et al *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 9 p Prepared jointly with Mitsubishi Atomic Power Ind., Inc., Ohmiya City, Japan (See N67-32404 18-22)

The necessary precautions which must be observed to assure good performance of steel irradiation tests are discussed in relation to capsule and rig design, fabrication, and irradiation. Details are given on the capsules selected for low temperature and high temperature irradiation, and on the techniques used to record temperatures. A schematic is included of the irradiation device which includes the retractable and rotatable rig, the channel plug, and the pneumatic blocking mechanism. To realize the planned fast neutron dose of over 1 MeV, the irradiation rigs were rotated and moved axially out according to the movement of peak plane of fast neutron flux during the irradiation. Upward displacement of the peak flux plane was simultaneously followed, and the rig position was corrected by steps of about 5 mm every 8 hours. Rig rotation over 120° at regular time intervals was required to eliminate the variation of neutron dose due to the radial fast neutron distribution. Obtained dosage results indicate that the ±10% maximum permissible deviation requirement was achieved. M.G.J.

N67-32409# Idaho Nuclear Corp., Idaho Falls.
LIMITED TEMPERATURE AND FATIGUE TEST CAPSULE EXPERIMENTS
F. O. Haroldsen *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 17 p (See N67-32404 18-22)
(Contract AT(10-1)-205)

Two unique capsule designs and associated problems are discussed. A splined type aluminum tube was used to encapsulate ATR surveillance beryllium samples. A shrink fit was employed to insure a good metal contact between the samples and the tube. It is shown how this design met the requirements of maintaining a sample temperature of less than 120°C, allowed void space for gas release, and did not excessively constrain the growth of the sample. A capsule for evaluating the irradiation effects on the fatigue properties of steels has been designed which permits cycling a specimen through an axial tension and compression cycle while in-reactor. The cycling can be controlled by the magnitude of stress of strain on the sample. Provisions have been made to measure and record the stress, strain, hysteresis energy, and the number of cycles to failure. The capsule is single containment which allows the more massive structural components to be cooled by reactor process water. Author

N67-32410# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
IN-REACTOR MECHANICAL PROPERTIES EXPERIMENTS
J. W. Woods *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 22 p ref (See N67-32404 18-22)
(Contract W-7405-ENG-26)
(ORNL-P-2162; CONF-660511-7)

The design and development of materials and techniques used in conducting mechanical properties experiments in the irradiation facilities of the Oak Ridge Research Reactor are discussed and illustrated. Detailed description of fabrication and operation of instrumented capsules used for stress–rupture testing, creep testing, and postirradiation studies are presented. A variety of materials tested include stainless steels, beryllium, Inconel, Hastelloy N, and graphite. Temperatures of the tests described cover a wide range: stress–rupture testing from 300° to 800°C, creep testing from 300° to 650°C, and postirradiation studies from 250° to 900°C. Auxiliary equipment such as heaters, loading systems, access tubes, junction boxes, and instrumentation is discussed. Author (NSA)

N67-32411# Oak Ridge National Lab., Tenn. Reactor Chemistry Div.
TECHNIQUES FOR IRRADIATING HIGH TEMPERATURE MATERIALS IN A STEEP FLUX GRADIENT
G. W. Keilholtz, R. F. Moore, M. F. Osborne, B. W. Wieland, and A. F. Zulliger *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 16 p refs (See N67-32404 18-22)
(Contract W-7405-ENG-26)

The J-12 core position of the engineering test reactor is used to irradiate high temperature materials under a variety of temperature and high neutron flux conditions. Specimen types include ceramic oxides, refractory metal carbides and nitrides, tensile test

specimens, and coated fuel particles. A maximum fast neutron dose of 8×10^{21} neutrons/cm^2 can be achieved in one calendar year. Several versatile multiple-capsule assemblies, and the facility in which they are operated, are described. Author

N67-32412# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
IRRADIATION SYSTEM FOR CRYOGENIC EXPERIMENTS IN THE PLUM BROOK REACTOR
F. A. Haley and R. R. Wyer *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 22 p refs (See N67-32404 18-22)

The irradiation system discussed consists of an experiment capsule assembly for holding experiment packages, an insertion system for placing of the experiment capsule in the Plum Brook Reactor (PBR), a data acquisition system for recording experiment data and controlling the experiment, and a cryogenic helium system for cooling and actuating experiments. In addition to the irradiation system, a brief description of the PBR is included. Author

N67-32413# Argonne National Lab., Ill.
COMPUTER PROGRAM FOR DETERMINING SPECIMEN AND IRRADIATION CAPSULE COMPONENT TEMPERATURE DISTRIBUTION
Charles F. Reinke *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 10 p Sponsored by AEC (See N67-32404 18-22)

A Fortran computer program was devised for the hazards analysis required before an experiment can be inserted into a test reactor. The program is set up to solve four basic heat transfer equations to determine the appropriate Δt (°C). The equations give the Δt (1) due to a contract resistance or film drop; (2) across a cylindrical specimen in which there is uniform internal generation of heat with dissipation at the outer surface; (3) across an annular section in which there is uniform internal generation of heat with dissipation only at the outer surface; and (4) due to steady state conduction in an annular section. The specimen and irradiation capsule are divided into a series of concentric annular regions, in which the Δt through each region can be divided into two components: steady state conduction, and uniform internal heat generation. Values for the thermal conductivity versus temperature for materials were obtained from the open literature. An example is included to clarify the procedure involved in using the program. M.G.J.

N67-32414# Oak Ridge National Lab., Tenn.
IRRADIATION CAPSULE TEMPERATURE CONTROL
J. A. Conlin *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 6 p (See N67-32404 18-22)
(Contract W-7405-ENG-26)
(ORNL-P-2177; CONF-660511-4)

Two of the most common methods used for irradiation capsule temperature control are the radial gas gap and/or supplemental electrical heat. Both methods have their limits, and these limits and their extensions are discussed. NSA

N67-32415# Atomics International, Canoga Park, Calif.
ASSESSMENT AND CORRELATION OF ERRORS IN PREIRRADIATION AND POSTIRRADIATION MEASUREMENTS
L. E. Demick *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 10 p (See N67-32404 18-22)
(Contract AT(11-1)-GEN-8)

Techniques and procedures developed for measurement system analysis are discussed, and measurement accuracy requirements are assessed. To assist the engineer in determining the steps required for minimizing error, the following rules were formulated: (1) The desired accuracy for a particular correlation is defined. (2) The measurement system or systems that must be used to generate data required for correlation are thoroughly analyzed for error sources. (3) Expressions for the interaction of sources of error in these systems and in propagation to a maximum error in the correlation are derived by standard techniques. (4) The required accuracy for each measurement is then back-calculated from the expressions derived and the quoted desired accuracy. An analysis of density measurement systems is given as an example to illustrate the methods used. Also discussed is the equipment developed for such measurements, including a profilometer for measuring pre-irradiation fuel rod and element diameters. M.G.J.

N67-32416# Atomics International, Canoga Park, Calif.
DIGITAL COMPUTER TECHNIQUES FOR THE HEAT TRANSFER ANALYSIS OF IRRADIATION ASSEMBLIES
T. A. Park *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 9 p (See N67-32404 18-22)
(Contract AT(11-1)-GEN-8)

Calculational techniques are presented for solving both design and analytical heat transfer problems. The gas annulus sizing program (GASP) was written in Fortran IV, with the equations programmed for solution on the IBM 7094 computer. The GASP code treats irradiation assemblies containing up to 30 regions, and uses temperature-dependent properties for up to 50 materials; it was designed to perform multiple calculations for parametric studies. Consideration is given to a gas annulus sizing model and design study, typical computer code lattice for analyzing a simple heat transfer model, heat transfer models for asymetric fuel rods, thermal conductivity correction factor, flux and temperature shaping, and axial temperature profile of prototype fuel element irradiation assembly using shaped gas annulus for temperature control. M.G.J.

N67-32417# Atomics International, Canoga Park, Calif.
THERMAL FLUX CALCULATIONS FOR EXPERIMENTS IN THE MTR
J. S. Buck *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 17 p (See N67-32404 18-22)
(Contract AT(11-1)-GEN-8)

Calculational techniques for predicting experiment operating power in the materials testing reactor (MTR) are described. These involve accurate determination of thermal flux levels in the test position, and accurate calculations of the flux perturbation that will be caused by a given experiment. This perturbation factor is defined as the ratio of the unperturbed thermal flux level to the perturbed flux level; the perturbed flux value refers to the average value in the fuel. The technique developed for MTR perturbation calculations is strongly influenced by the geometrical location of the test positions. Reactor flux distributions and neutron spectra are examined to show their influence on the flux perturbation calculations. The nuclear analysis and design of a specific experiment is described in detail to illustrate the fineness that must be used to obtain accurate answers. M.G.J.

N67-32418# General Electric Co., San Jose, Calif. Nuclear Technology Dept.
CAPSULE DESIGN FOR ISOTHERMAL IRRADIATION OF UO_2
G. A. Esswein *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 8 p (See N67-32404 18-22)
(Contract AT(04-3)-189)

Four capsules have been irradiated in the test reactor to determine the fission gas release fraction from sintered UO_2 fuel while operating isothermally at nominal temperatures of 1500°, 1700°, 1900° and 2100°C. The purpose of these irradiations was

to refine the knowledge of the UO_2 fission gas release variation within the critical temperature range for release, i.e., the temperature range between ≈1500°C and 2100°C over which the release fraction increases from below 1% to nearly 100%. A unique capsule design was evolved for the irradiations with the objective of minimizing radial and axial temperature gradients within the isothermal sample and maintaining a constant sample temperature over a period of days, despite continuous neutron flux variations. The actual fission gas data obtained from the capsules was partially compromised by repeated cracking of the tungsten cladding enclosing the isothermal UO_2 samples. However, the ultimate capsule design performed beyond expectations in achieving and maintaining the desired operating conditions. Author

N67-32419# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
MOLTEN FUEL IRRADIATION TESTS
L. A. Pember, F. E. Panisko, and M. K. Millhollen. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 4 p (See N67-32404 18-22)
(Contract AT(45-1)-1830)

A series of tests have been irradiated in an attempt to determine the possibility of molten fuel impinging the cladding through cracks formed during a reactor shutdown or during operation. In an attempt to simulate rather gross cracks, capsules containing UO_2 pellets, one pellet of which had a hole drilled along a diameter, were irradiated. Two tests, one single rod element and one four rod cluster, were irradiated in the B-3 facility to determine the effect of a gross crack during a normal reactor startup. Four capsules were irradiated in the VH-4 hydraulic rabbit facility to determine the effect of a nearly instantaneous increase in power or of a crack occurring during operation. Data on each test are assessed. Author

N67-32420# California Univ. Livermore. Lawrence Radiation Lab.
IN-PILE CALORIMETRY
Robert Parker and James Eagan. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 13 p refs (See N67-32404 18-22)
(Contract W-7405-ENG-48)
(UCRL-14786; CONF-660511-8)

An experiment is proposed in which capacitor pulse heating techniques would be used to determine in-pile specific heat data for various materials of interest in reactor design as a function of exposure to integrated neutron flux. The pulse heating method is a relatively new technique which uses the electric discharge of a known amount of energy stored in a capacitor bank through a given sample to rapidly (30 μsec) heat it. By measuring the temperature rise and knowing the energy stored, the specific heat of conductors may be computed. Among the many advantages associated with this technique is the fact that this entire operation may be performed remotely and repeatedly over long time intervals with good precision. Hence, it offers the unique opportunity of providing data on specimens subjected to a neutron flux (5×10^{13} n/cm^2 sec) without having to remove the specimen from the flux, as would normally be the case with more conventional calorimetric test methods. The features of the capsule design are outlined. Detailed capsule sketches and electric bus bars are shown in the proposal, as well as a list of material and total integrated neutron flux exposures that the materials will experience. Analytical expressions governing the electrical pulse heating method are derived. In addition, the test procedure is outlined. NSA

N67-32421# Battelle-Northwest, Richland, Wash. Process Metallurgy Section.
CONTROLLED TEMPERATURE–PRESSURE IRRADIATION CAPSULES
R. D. Leggett and C. R. Hann. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 19 p refs (See N67-32404 18-22)
(Contract AT(45-1)-1830)

Details are given on the controlled temperature and controlled temperature–pressure, NaK filled irradiation capsules that were developed in conjunction with a program designed to study the basic mechanisms of the swelling (increase in volume) which occurs during the irradiation of fissionable and fertile metallic fuels. These capsules are used to study the effects of temperature; external restraint; specimen composition structure, and geometry; burnup; and burnup rate on the behavior of metallic fuel specimens during irradiation. Physical descriptions of the capsules which have a controlled temperature range of 200°–800°C and a controlled pressure range of 30–5000 psi are provided. A brief discussion is included on the design of the pressure shell, a new weld configuration used, and the effects of high pressure helium on heat transfer. The high integrity components, the extreme care exercised during construction, and the improved instrumentation have provided a successful irradiation device for studying the behavior of fissionable materials. Author

N67-32422# Oak Ridge National Lab., Tenn.
AN ASSEMBLY FOR IRRADIATION OF MOLTEN FLUORIDE FUEL TO HIGH BURNUPS IN THE OAK RIDGE RESEARCH REACTOR (ORR)
H. C. Savage, J. M. Baker, M. J. Kelly, and E. L. Compere. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 4 p refs (See N67-32404 18-22)
(Contract W-7405-ENG-26)

An irradiation assembly was designed to study the effects of radiation and fissioning on molten fluoride fuel salt and construction materials. Irradiation experiments are to be carried out in a horizontal beam hole facility in the Oak Ridge research reactor as part of the molten-salt reactor program. Objectives of these irradiation experiments are to simulate conditions expected to exist in an operating molten salt reactor. These conditions include a nominal operating temperature of 1200°F, fuel circulating through regions of different temperatures in contact with Hastelloy N piping and graphite, high power density and removal of gaseous fission products, and extended operating time; at least one year is desired. The extended operating time is expected to result in 50% burnup of fuel with an opportunity to study fission product chemistry at high concentrations. Author

N67-32423# Los Alamos Scientific Lab., N. Mex.
AN IRRADIATION CAPSULE FOR MOLTEN Pu ALLOYS
P. J. Peterson. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 8 p ref (See N67-32404 18-22)
(Contract W-7405-ENG-48)
(LA-DC-7772; CONF-660511-10)

Design of a static capsule for use in studying fission product distribution between molten Pu fuel and Na in reactor-type environments is described. The Pu fuel alloy is contained in a sealed Ta pin. Results of testing the design are discussed. NSA

N67-32424# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
ADVANCES IN NaK ENCAPSULATION TECHNIQUES AT THE SAVANNAH RIVER LABORATORY
W. N. Rankin, E. F. Sturcken and W. R. McDonell. *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 16 p refs (See N67-32404 18-22)
(Contract AT(07-2)-1)
(OP-MS-66-1; CONF-660511-9)

Preparations for testing irradiation growth and cavitation swelling in U and U alloys were investigated. The capsule loading

chamber was modified to double the number of capsules that can be loaded at one time. A new method was developed for sealing the capsules. The vacuum system was improved, and the pump-down time reduced by a factor of ten. Other modifications were introduced that simplify and increase the safety during the mounting, filling, and sealing of the capsules and the removal of NaK from the system after loading. Advances were also made in test specimen design. Techniques were developed for strain-free machining of spherical specimens, and for directionally indexing them with rectangular holes. The spherical specimen greatly reduces the necessary number of test specimens for irradiation growth experiments, since data for growth in all directions can be obtained from a single specimen. NSA

N67-32425# Atomics International, Canoga Park, Calif.
DESIGN, ASSEMBLY, AND OPERATION OF URANIUM ZIRCONIUM–HYDRIDE FUEL IRRADIATIONS
J. E. Kinzer *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 21 p refs (See N67-32404 18-22)
(Contract AT(11-1)-GEN-8)

An experiment design is discussed in which the in-pile assembly consisted of six separate experiments in series, each having independent instrumentation and control systems. Two of the experiments have four sublength fuel elements; the other four have one sublength element, for a total of 12 specimens. The number of specimens in each experiment is determined by the number of variables to be investigated at a particular operating temperature. It is shown why this approach was chosen for investigating the three-dimensional matrix of variables which must be accommodated in order to optimize the particular fuel design in question. Data are given on the cycle of analysis, design, fabrication, assembly, operation, and postirradiation examination. It is concluded that the assembly demonstrated the validity of the concept of integrating the control of more variables than had been accomplished previously. M.G.J.

N67-32426# General Electric Co., Cincinnati, Ohio.
CAPSULE FOR RECOIL FISSION PRODUCT STUDIES
R. A. Pugh and W. S. Chensult *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 9 p (See N67-32404 18-22)

Design criteria are presented on a recoil fission product capsule consisting of a tungsten test specimen surrounded by a surface containing fissionable uranium 235. During irradiation, the fission products recoiling from this surface would strike and diffuse into the test specimen. Ceramic tubes are used to house the specimens; these tubes are either depleted UO_2 with a 0.001-inch layer of enriched UO_2 on the inside diameter, or depleted UO_2 alone. A subassembly, consisting of six specimens in tandem inside the UO sleeves, are sealed in rhenium tubes for insertion into a massive molybdenum cylinder. Similar design data are presented on the capsule for thermocouple studies. A reference mass concept is used. The temperature is continuously monitored by thermocouples undergoing irradiation, and it can be calibrated periodically by identical thermocouples which can be inserted and withdrawn to minimize exposure to irradiation. Preirradiation cleanup procedures, to outgas the cartridge and connecting inert gas lines, are summarized. M.G.J.

N67-32427# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
IN-PILE MEASUREMENT OF THE THERMAL EMF OF $UO_{2.00}$
L. A. Pember *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 4 p (See N67-32404 18-22)
(Contract AT(45-1)-1830)
(BNWL-SA-680)

Tests were conducted to determine the thermal electromotive force (emf) produced by a UO_2 fuel core during irradiation. The capsule for the electrical resistivity and emf measurements is depicted and described. This capsule was irradiated in the materials testing reactor, and measurement of open circuit voltage, short circuit current, and load voltage versus load current were made during reactor startup. At a calculated core temperature of 1000°C, an open circuit voltage of 330 millivolts and a short circuit current of 56 milliamperes were measured. At this power a resistance of 3.4 ohms was calculated; with increased power, a polarity reversal was noted. After a reactor scram, readings during power recovery followed a curve of the same general shape, although slightly displaced, from the original curve. This was considered an indication that enough structural development had occurred to improve the thermal conductivity appreciably. M.G.J.

N67-32428# Oak Ridge National Lab., Tenn.
A DILATOMETER FOR MEASURING AXIAL DISPLACEMENT OF FUEL DURING IRRADIATION
F. R. McQuilkin, T. L. McLean, V. A. De Carlo, and R. L. Senn *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 4 p refs (See N67-32404 18-22)
(Contract W-7405-ENG-26)
(ORNL-P-2179; CONF-660511-8)

Axial displacement of UO_2 fuel pellets during irradiation was measured with a dilatometer employing a commercial pneumatic linear motion transducer. A bellows sealed push-rod, coupling the fuel stack to the transducer, provided a unique arrangement for penetrating the fuel encapsulating can. The dilatometer is described. NSA

N67-32429# United Kingdom Atomic Energy Authority, Dounreay (Scotland).
THE TEMPERATURE CONTROL OF ENCAPSULATED IRRADIATION SPECIMENS
J. M. Robertson, G. H. French, and A. E. Jenkins *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 24 p refs (See N67-32404 18-22)

Methods of achieving and controlling the temperature of a specimen are presented as an aid to the experimenter and capsule designer for improved control of irradiation conditions. Several of the methods exhibit the common property of strong dependence of the thermal insulation on the pressure of the gas filling. The development work reported includes research on loose ceramic powders, sprayed ceramics, wrapped metallic foil, variable width gas gap, variable position devices, double-walled capsule with circumferential fins, and reflux capsules. M.G.J.

N67-32430# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
DEVELOPMENTS IN IRRADIATION CAPSULE TECHNOLOGY AT GENERAL ATOMIC
F. D. Carpenter, J. O. Barner, B. B. Spillane, and W. P. Wallace *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 57 p refs (See N67-32404 18-22)
(Contracts AT(04-3)-167; AT(04-3)-187; AT(04-3)-633)

The approaches taken to evaluate and design test capsules used in the nuclear development programs are described. A guide to selecting proper materials for a specific capsule design is presented, with emphasis placed on high temperature and high flux exposure requirements and on physical integrity in the capsule design. Consideration is given to the outer or secondary containment, the thermal spacer, the inner or primary containment, and the thermocouples, along with methods of joining the selected materials. Design criteria are provided on a broad temperature-controlled irradiation capsule, and comparisons are drawn between predicted and actual performance in the engineering test reactor (ETR).

Experiences associated with problem areas in a specific capsule design are recounted, with details given on the approaches taken to improve techniques in material compatibility, brazing, thermometry, dosimetry, and instrumentation. M.G.J.

N67-32431# Battelle Memorial Inst., Columbus, Ohio.
A CAPSULE DESIGN FOR THE IRRADIATION OF EIGHT FUEL SPECIMENS AT EACH OF THREE TEMPERATURES
Neil E. Miller *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 8 p (See N67-32404 18-22)
(Contract W-7405-ENG-92)

In order to evaluate the fission gas retention properties of coated fuels as a function of temperature to high burnup, a capsule was designed in which eight fuel materials are accommodated, with one specimen of each type fuel in three different temperature zones. The capsule is to be irradiated in the high flux regions of the engineering test reactor (ETR). To assure compatibility, graphite was used as a fuel container and high temperature structural material. The specimen assemblies, from top to bottom, operated at nominally 550°, 1150°, and 1300°C peak temperatures. These temperature zones were obtained by varying the heat transfer path from, and the heat generation in, each specimen assembly. Operational experience is discussed, and the problems which were encountered are assessed. Details are also given on a coating integrity evaluation technique, in which the fraction of coating failure was determined from the quantity of released xenon 133. M.G.J.

N67-32432# Battelle Memorial Inst., Columbus, Ohio.
IRRADIATION CAPSULE DESIGN FOR OPERATION TO 2000°C
William J. Zielenbach *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 12 p (See N67-32404 18-22)
(Contract W-7405-ENG-92)

Design criteria are presented on an irradiation capsule concept capable of 1600° to 2000°C specimen cladding temperature, with emphasis placed on heat transfer, thermocouple location, and structural integrity. Satisfactory temperature monitoring in the capsule system is identified as the leading design problem, and various concepts are assessed in order to develop the most acceptable compromise situation. Also discussed are the approaches taken to provide a range of specimen temperature control during in-pile operation, and the heat transfer studies which used a two-dimensional, finite difference digital computer program to calculate temperature profiles in a combined axial–radial heat flow situation. Nuclear mockup studies were performed to examine changes in specimen temperature profile caused by the variation in cladding diameter and subsequent depression of the heat generation in the fuel adjacent to the thick cladding section. These results were used in the computer code to predict the expected research reactor irradiation specimen temperatures. The proposed capsule irradiation experiments are discussed. M.G.J.

N67-32433# General Dynamics Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
DESIGN OF AN IN-PILE CAPSULE POSITIONING MECHANISM
J. H. Sleigh, W. W. Godsin, and J. T. Ream *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 13 p (See N67-32404 18-22)
(Contract NAS3-6471)

A device capable of automatically and remotely adjusting the position of irradiation capsules in the Plum Brook Reactor Facility was designed, fabricated, and tested. The latitude of movement covers a thermal neutron flux range of about a factor of 10. This device, a capsule positioning mechanism, (CPM), is mated to a 9" O.D. cylindrical vertical test tube facility, and consists of a hydraulic cylinder with its shaft directly coupled to a movable carriage supported by bearings on steel tracks. Reactor primary water serves as the hydraulic fluid for the system and motion is initiated by signal from a temperature recorder monitoring selected capsule thermocouples. Fail safe automatic and manual control features provide fuel temperature control through CPM movement with or without personnel attendance. Author

N67-32434# General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.
IN-CORE VERTICAL ADJUSTABLE FACILITY FOR CAPSULE IRRADIATIONS IN THE NASA PLUM BROOK REACTOR
T. L. Gregory *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 7 p (See N67-32404 18-22)
(Contract NAS3-2544)

A mechanical device has been designed for use in an in-core position in the Plum Brook reactor to allow a maximum of ten inches of vertical movement with respect to the core. Such a device has been built and is in use. It has proved an economical electro-mechanical device for remotely positioning a capsule in a core position. This device was designed as part of a high-temperature fuel form irradiation. Only the in-core repositioning facility is described. The most significant aspect of this device is that it permits in-core vertical capsule positioning through a linear motion pressure vessel penetration. Position is measured with respect to the core by using a position-indicating transducer mounted outside the pressure vessel on the drive unit. The equipment installed in the reactor vessel is depicted. Author

N67-32435# Argonne National Lab., Ill.
A DESIGN OF A FLUX POSITIONING CAPSULE FOR USE IN THE VERTICAL THIMBLES OF THE CP-5 REACTOR
W. N. Beck *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 9 p refs Sponsored by AEC (See N67-32404 18-22)

A specially designed extension tube assembly permits remote positioning of an instrumented irradiation capsule within the vertical thimbles of the CP-5 reactor. The assembly has a total travel of 15 inches and is manually operated from the top of the reactor. The assembly has been used to control irradiation specimen temperature as well as means of flux mapping the fuel tubes. Author

N67-32436# Westinghouse Electric Corp., Pittsburgh, Pa.
AN AUTOMATED POWER AND PRESSURE CYCLING SYSTEM FOR ELEVATED TEMPERATURE FOR IRRADIATION OF THIN CLAD FUEL PINS
R. E. Schreiber and A. E. Kemmerer *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 19 p (See N67-32404 18-22)

Design details are presented on a system for automatic, yet independent, cycling of temperature, pressure, and power in fuel-bearing instrumented capsules. Temperature and pressure levels are those of interest in fast and superheat reactors, as well as conventional water reactors. Schematics are included, and the main system components are described: fuel pin and inner capsule, outer capsule, and raft facility to provide power cycling, and gas pressurization and thermal control systems. The proposed method directly relates fuel element endurance to the operating variables, and is intended to provide a flexible arrangement for performing endurance tests of fuel pins. M.G.J.

N67-32437# Battelle Memorial Inst., Columbus, Ohio.
SURVEILLANCE OF IN-PILE TESTS USING NEUTRON RADIOGRAPHY
Wayne A. Carbiener *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 8 p refs (See N67-32404 18-22)

Neutron radiography as a means of nondestructively examining radioactive materials is discussed. The technique involves using the reactor core as a neutron source and the pool water as a biological shield, thereby precluding the fabrication of costly additional shielding. Examples are given to show its application to stainless steel irradiation capsules containing nuclear fuel, and to doubly contained, high burnup fuel capsules containing liquid sodium. The technique is also considered a valuable tool in analyzing fuel development programs, whereby the fuel specimens can be radiographed upon completion of the in-pile test and subsequent removal from the encapsulation. M.G.J.

N67-32438# Oak Ridge National Lab., Tenn. Reactor Chemistry Div.

IN-PILE PROPERTIES OF REACTOR FUELS BY OSCILLATING TECHNIQUES

R. M. Carroll and O. Sisman *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 21 p refs (See N67-32404 18-22)

(Contract W-7405-ENG-26)

The application of the oscillating technique to fission gas release experiments is discussed, and it is shown that much additional information is obtained by operating over a range of frequencies and studying the resultant effect on the amplitude and wave shape of the fission gas release curve. The experiment consists of a single-pass sweep capsule hung vertically in an air-cooled irradiation tube extending into the reactor core of the Oak Ridge research reactor. The positioning system and method of flux oscillation, the temperature control and oscillation system, and the method of handling the output data from the fission gas experiments are described in detail. Qualitative observations are made to illustrate the kind of results which the oscillating experiments give that are not possible to obtain with steady state experiments. M.G.J.

N67-32439# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

DESIGN AND FABRICATION OF A LIQUID METAL TEMPERATURE CONTROLLED IRRADIATION CAPSULE

T. T. Claudson *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 32 p ref (See N67-32404 18-22)

(Contract AT(45-1)-1830)

(BNWL-SA-604; CONF-660511-1)

The capsule design can be divided into three portions. The inner portion contains a specimen chamber and a vacuum insulation layer. The next layer is an annulus through which the liquid metal coolant can flow, and the third portion can be considered as the capsule inner and outer containment walls and the temperature control gas annulus between these walls. The capsule utilizes convective flow and was fabricated from type 304 stainless steel. NSA

N67-32440# General Electric Co., San Jose, Calif. Atomic Products Div.

DESIGN, DEVELOPMENT AND OPERATION OF A NaK FILLED NATURAL CONVECTION CIRCULATING CAPSULE

F. W. Knight, H. C. Pfefferlen, and R. H. Leyse *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 17 p (See N67-32404 18-22)

(Contract AT(04-3)-189)

Design criteria are presented on a natural convection circulating capsule being developed for use with a fast, ceramic-fueled, sodium-cooled reactor. Due to the difficulties involved in providing for sodium melting in the capsule design, it was decided to use NaK as the coolant since it is molten at room temperature. A natural circulation loop analysis computer program is presented which solves for, and prints out, the value of the steady-state flow as well as the bulk NaK temperature at five places within the loop for any set of capsule parameters desired. It is concluded: (1) The natural convection circulating capsule concept is practical for the irradiation of fuel elements requiring a liquid metal environment, and will minimize the problem of gas blanketing and cladding burnout in a thin-bond annuli. (2) Flowing liquid metal is much more prototypical of most reactor applications than stagnant liquid metal. (3) Fuel element temperature can be predicted accurately, which proves useful in experiments using liquid metals as coolants. M.G.J.

N67-32441# Los Alamos Scientific Lab., N. Mex.

THE IRRADIATION OF LIQUID PLUTONIUM FUELS IN A THERMAL REACTOR

R. L. Cubitt, G. L. Ragan, and D. C. Kirkpatrick *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 28 p refs (See N67-32404 18-22)

(Contract W-7405-ENG-36)

(AL-DC-7753; CONF-660511-3)

The in-pile irradiation program which has been in progress at the Los Alamos Scientific Laboratory (LASL) since January 1964 is described. The purpose of this program is to obtain preliminary irradiation data on the liquid plutonium alloy fuels and tantalum containers that will be used in the Fast Reactor Core Test Facility (FRCTF). Thus, the irradiations are performed under operating conditions and environment simulating those expected in the FRCTF; i.e., fuel-container interface temperatures are maintained above the fuel freezing point of approximately 440°C and below 725°C during all phases of reactor operation and shutdown. The irradiations are accomplished in LASL's 5.0 MW MTR-type reactor, the Omega West Reactor (OWR). The technique developed employs a natural convection sodium loop located in the OWR core where the fast and epithermal neutron flux components are highest. A tantalum fuel capsule containing 24 g of Pu–Co–Ce fuel (6.2 g Pu/cc) placed in the loop operates at an average specific power of 150 W/g plutonium. With the present reactor operating schedule, 1% burnup is achieved in about 10 weeks. Author (NSA)

N67-32442# United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center.

A COMPARISON OF FUEL BURNUP DETERMINATIONS

John J. Cihi *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 10 p refs (See N67-32404 18-22)

Burnup determination data are compared for two irradiation programs in which a total of 22 specimens were available with burnups ranging from 16,000 Mwd/MT fuel to 114,000 Mwd/MT fuel. One involved the irradiation of (Pu+UIC fuel samples irradiated in the test reactor. Two methods were used to estimate burnup: a calorimetric method with a heat meter built into the capsules from which burnup was calculated, and burnup based upon an estimate of neutron flux at the specimens. In addition, an isotopic analysis was made of the fuel samples, and an estimate was made based on the integrated flux dose received by the flux monitor wires. In the other program, the materials testing reactor was used to irradiate UO_2 cermet fuels; burnup was determined by the capsule calorimetry method during irradiation, and isotopic analysis of the fuel at the end of irradiation. Each method is described. It was concluded: (1) The calorimetric method is workable and shows good agreement with isotopic results to burnups of 40,000 Mwd/MT fuel. (2) Reactor operators can predict burnup in good agreement with isotopic analysis performed at the end of irradiation. M.G.J.

N67-32443# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

EFFECT OF REACTOR CORE CHANGES ON NEUTRON SPECTRA

J. W. Helm *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 10 p refs (See N67-32404 18-22)

(Contract AT(45-1)-1830)

Several variations of the loading of the test reactor core in positions adjacent to the positions in which graphite capsules are irradiated were analyzed. In general, changes in materials within the irradiation position perturb the neutron spectra, change the fast flux intensity, affect the effective cross sections for flux monitoring materials, and change the number of displacements occurring. However, changes made in the adjacent positions produce smaller perturbations, with the exception of drastic changes such as replacing control fuel with poison. The results point out: (1) With knowledge of the neutron spectra and effective cross sections, the flux, E > 0.18 MeV, provides a very accurate indication of the damage to graphite even when large variations in reactor loadings occur. (2) Once the detailed neutron spectra and effective cross sections are determined for an experiment, they will continue to be valid even though large variations in core loadings are made in adjacent reactor positions. Author

N67-32444# Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.

A GAMMA THERMOMETER

R. E. Schreiber *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 19 p refs (See N67-32404 18-22)

To determine the irradiation embrittlement of certain steels, a gamma thermometer was developed to measure the gamma heating in the periphery of the Saxton reactor core. It is pointed out that the use of a measuring device made of the same material as the irradiation specimens is more accurate than any estimation method. The design is depicted and described, and equations are derived for the steady state, one-directional heat conduction. Calibration methods and in-pile operation are discussed. In addition to measuring in-core gamma heat, the gamma thermometer is considered useful for such other measurements as the transient thermal properties of reactor structural material, effects of irradiation on thermal conductivity, and spatial power oscillations in large reactor cores. M.G.J.

N67-32445# Westinghouse Electric Corp., Pittsburgh, Pa.

POWER AND FUEL DEPLETION CALCULATIONS FOR NON-INSTRUMENTED CAPSULES IN NASA'S PLUM BROOK REACTOR FACILITY

R. E. Schreiber *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 38 p refs (See N67-32404 18-22)

(Contract NAS3-3392)

To schedule the absorber and reactor position changes and to predict when the desired burnup is reached, a mathematical model was developed to determine power and uranium 235 atomic density changes in fuel-bearing capsules as functions of time. Data are derived on the unperturbed flux in the various reactor positions, and on the perturbing effects of fuel and absorber sleeves. Several gold foil activation runs were made with dummy capsules containing UO_2 fuel pellets in the low power mockup reactor (MUR) at the Plum Brook Reactor Facility. The capsule design, the MUR experiments, and the application of the model to determine a typical scheduling sequence are described. Basic equations are formulated for treating burnable poisons, such as boron 10, used in conjunction with the experiment. Extensive data are also included on flux perturbation measurements for C- and F-factor calculations. M.G.J.

N67-32446# United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.

HEATERS FOR IRRADIATION EXPERIMENTS

N. H. Hancock *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 52 p refs (See N67-32404 18-22)

Resistance heaters of mineral-insulated cable form have been manufactured and developed to a high standard, and the further development to extend their working temperature up to 1200°C by the use of refractory and noble metals is detailed. A range of bare metal, ceramic, and cermet heaters is being investigated for continuous operation in reactor experiments at about 1600°C. Laboratory tests have established useful data on high-temperature compatibility, grain growth, evaporation, and oxidation rates in inert gas atmospheres. Design data and experience are presented for both induction and low-voltage resistance heating, these systems having been applied to a number of reactor engineering experiments. Heat transfer work involving surface heat fluxes in excess of 400 watts/cm^2 has required the development of a heat source more powerful and reliable than a resistance heater; some work on a thermionic device for this purpose is described. Author

N67-32447# United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.

THE USE OF NOBLE AND REFRACTORY METAL THERMOCOUPLES IN EXPERIMENTAL IRRADIATION EQUIPMENT

N. H. Hancock *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 5 p ref (See N67-32404 18-22)

The advantages and disadvantages of platinum–rhodium and tungsten–rhenium alloy thermocouples are assessed in relation to their use for reactor measurements at temperatures above 1000°C. The attractive properties of platinum–rhodium thermocouples for measurements up to 1500°C are cited as excellent oxidation resistance, and workability, accurately known and reproducible calibration, and availability in sheath form. Disadvantages are high neutron absorption cross section of rhodium, and the incompatibility of platinum with reducing conditions. Tungsten–rhenium alloy thermocouples are used for operations above 1500°C. Disadvantages are listed as general lack of oxidation resistance, and poor ductility of pure tungsten; both disadvantages are acceptable, however, for experimental work. In general, it is concluded that the thermocouple error due to transmutation is very difficult to predict since it involves the neutron flux distribution along the thermocouple, the temperature distribution, and the rate of change of thermoelectric emf with composition change. M.G.J.

N67-32448# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.

IRRADIATION EFFECTS ON THERMOCOUPLES

J. W. Helm *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 5 p refs (See N67-32404 18-22)

(Contract AT(45-1)-1830)

Postirradiation calibration data are presented on thermocouples used to monitor the sample temperatures of experimental capsules in high flux test reactors. It was concluded that changes in calibration are probably due to a transmutation of the elements in the wire; these changes indicate that rather large errors can exist in temperatures read out by thermocouples during service in irradiation capsules. M.G.J.

N67-32449# Atomics International, Canoga Park, Calif.

INSTRUMENTATION AND DATA REDUCTION TECHNIQUES FOR IRRADIATION EXPERIMENTS

D. B. West *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 9 p (See N67-32404 18-22)

(Contract AT(11-1)-GEN-8)

Custom solid-state data acquisition and temperature control systems are described; these were designed to meet the complex requirements of evaluating fuel element performance over a wide range of compositional variables, temperatures, burnups, and burnup rates. Experiment temperature control is accomplished by varying the thermal conductivity of the heat path between the fuel specimen and the reactor coolant. This is done by adjusting the ratio of helium and argon gases in an annulus located between the fuel and the coolant. Key component of the system is identified

as a pressure differential monitor which detects pressure variations in either control gas, as well as variations in gas flow. Data acquisition is obtained by using solid-state data loggers with punched paper tape output. High/low temperature alarms, as well as the command logic for the gas control modules, are provided. A three-dimensional plugboard provides versatile programming of high/low limit values and mode control of each thermocouple channel, with provision to skip or force-to-000 on each channel. A data processing flow diagram is included. M.G.J.

N67-32450# General Electric Co., San Jose, Calif.
THERMOCOUPLE DEVELOPMENT FOR USE IN MEASURING OXIDE FUEL TEMPERATURES IN-PILE ABOVE 4000°F
P. E. Novak and R. R. Asamoto *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 6 p refs (See N67-32404 18-22)
(Contract AT(04-3)-540)

Investigations are under way to determine the performance of W3Re/W25Re and W5Re/W26Re thermocouples up to 4700°F for up to 1800 hours in (Pu, U)O_2 fuel. Bare wire thermocouples were calibrated up to 5400°F and thoria insulated; W26Re sheathed thermocouples were calibrated to 5100°F. The compatibility of W26Re and Ta with mixed oxide was studied up to 4700°F. Author

N67-32451# United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center.
NONDESTRUCTIVE TESTING OF THIN SODIUM ANNULI TO DETECT VOIDS
John J. Cihi and Milton L. Langham *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 26 p (See N67-32404 18-22)

For the fabrication and inspection of capsules to be irradiated in the Experimental Breeder Reactor (EBR)-II, a nondestructive testing method was developed to find voids in the sodium annulus between the fuel rod clad outer diameter and the capsule wall inner diameter. An eddy current test procedure was developed which uses a constant-rate longitudinal traverse of the capsule with an eddy current probe, energized by a sine wave at the test frequency while the capsule is rotated at a constant speed. Voids in the sodium annulus cause changes in the detection system which are visually displayed on an oscilloscope screen and are recorded simultaneously on a strip chart. Program development consisted of (1) inspection of simulated capsules and correlation with eddy current traces, (2) fabrication and inspection of a defect standard against which the final assembled rods can be compared, and (3) inspection of actual fuel capsules. Recommended procedures for eddy current inspection of EBR-II fuel capsules are listed. Correlation between the eddy current strip charts and the destructively tested simulated capsules was considered excellent. M.G.J.

N67-32452# Phillips Petroleum Co., Idaho Falls, Idaho.
BURST IRRADIATION FACILITIES AT THE NATIONAL REACTOR TESTING STATION AND A REVIEW OF THE SUBASSEMBLY TESTING PROGRAM
R. W. Miller and J. E. Grund *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 30 p refs (See N67-32404 18-22)

A small-scale capsule or subassembly test approach is taken to the study of destructive processes and the behavior of integral reactor systems under accident conditions. Experiments are designed to determine the causality of fuel element failure; interactions and reactions between the fuel element and its environment that are important in determining the severity of an accident; and the nature of release, transport, and deposition of fission products following failure of the initial containment in the fuel element. Consideration is given to two major fuel element types: rod-type elements of UO_2 pellets or powder clad with zirconium or stainless steel; and highly enriched, metallic, plate-type elements clad with aluminum, zirconium, or stainless steel. Details are given on two reactors designed to satisfy the proposed test program and necessary safety requirements. The power burst facility is an oxide-fueled, epithermal, water-moderated reactor for operation in the transient mode at reactor periods down to 1 μsec; the simpler and less capable capsule driver core uses available powdered UO_2 fuel, swage-compressed in stainless steel cladding. M.G.J.

N67-32453# Phillips Petroleum Co., Idaho Falls, Idaho.
DEVELOPMENT OF CAPSULES AND LOOPS FOR DYNAMIC PRESSURE CONTAINMENT
T. F. Lagier, W. E. Driskell, and W. R. Day *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 20 p refs (See N67-32404 18-22)

An out-of-pile test program was conducted to determine the behavior of potential capsule materials in a dynamic pressure environment, and the size of the capsules required to contain the in-pile experiments. Open-ended cylinders were subjected to line charges of Primacord explosives in a water environment; their lengths were specified so that the cylinders would respond as if infinitely long except near the ends. Sizes and mechanical properties of the test cylinders are tabulated, along with the burst characteristics. Permanent deformation data obtained from cylinder tests are correlated, and rupture and deformation patterns are illustrated. Loop filter experiments were also conducted to evaluate the types of filters suited to damp out transient pressures propagating through in-pile loop experiments. The design selected consisted of an expansion chamber to attenuate high frequency pressure pulses, and a series of air expansion volumes to attenuate low frequency pressure pulses. M.G.J.

N67-32454# Phillips Petroleum Co., Idaho Falls, Idaho.
TESTING AND APPLICATION OF DETECTORS FOR MEASUREMENT OF DYNAMIC PHENOMENA DURING BURST IRRADIATION CAPSULE EXPERIMENTS
K. O. Johnson and D. D. Gibson *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 32 p refs (See N67-32404 18-22)

Instrumentation problems associated with the measurements of mechanical and nuclear energy within the capsule are discussed in relation to the adverse environmental conditions of large magnitude transient radiation fields and explosive pressure fields. Transducer devices are selected to withstand these environs and respond to the signal rates which are generated. Illustrations are included to show the instrumentation employed for a typical capsule drive core (CDC) capsule experiment, which consists of a pressure transducer, strain gauges, a cobalt wire, thermocouples, and a growth ring on the fuel rod. Out-of-pile testing performed to evaluate transducers and mechanical energy release measurement techniques are discussed, and data from in-pile tests performed in the CDC are presented. Details are also given on a calorimetric capsule designed for nuclear energy release measurements, and on fuel rod performance measurements of cladding surface temperature, fuel temperature, and cladding strain. Supplementary information is included on the transient data instrumentation system, and on data reduction and processing. M.G.J.

N67-32455# United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group.
THE ORGANIZATION AND ADMINISTRATION OF THE IRRADIATION PROGRAMME FOR THE FAST REACTOR DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT
G. M. Jones *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 11 p (See N67-32404 18-22)

Details are given on a flexible organizational plan which was evolved to coordinate the development, design, manufacture, and assembly of irradiation experiments in order to meet the preset target dates for reactor loading. Terms of reference for use by the Project Office are defined. Procedures are outlined for preparing the irradiation experiments for a specific reactor date, and on maintaining full records of each experiment. Summary data are presented on the experiments developed and used for fast reactor work. Additional management tools are suggested for irradiation programs, such as the use of critical path networks for development subprojects, critical path analysis for resource planning, and value analysis in the early stages of discussion to determine whether the results to be obtained are worth the financial investment in the experiment. M.G.J.

N67-32456# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
CAPSULE IRRADIATION EXPERIMENTS AT CHALK RIVER
A. W. Boyd *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 12 p refs (See N67-32404 18-22)

Brief summaries are presented on the various research projects pertaining to capsule irradiation. Attention is centered on the areas of novel capsule design, flux determination and control, capsule components and fabrication, and reactor characteristics affecting experiments. M.G.J.

N67-32457# Douglas United Nuclear, Inc., Richland, Wash.
CAPSULE IRRADIATIONS IN THE HANFORD PRODUCTION REACTORS
C. E. Bowers *In* AEC Intern. Symp. on Develop in Irradiation Capsule Technol. Mar. 1967 5 p (See N67-32404 18-22)
(Contract AT(45-1)-1857)
(DUN-SA-7; CONF-660511-2)

A review of test irradiations conducted at Hanford is presented. General irradiation descriptions, unique capsules and irradiations, reactor characteristics and experiments, and test analyses are briefly described. NSA

N67-32458# Oak Ridge National Lab., Tenn. Solid State Div.
IRRADIATION FACILITIES IN THE OAK RIDGE NATIONAL LABORATORY BULK SHIELDING REACTOR
C. E. Klabunde and B. C. Kelley *In* AEC Intern. Symp. on Develop. in Irradiation Capsule Technol. Mar. 1967 19 p refs (See N67-32404 18-22)
(Contract W-7405-ENG-26)
(ORNL-P-2160; CONF-660511-5)

Five unique irradiation facilities for materials testing and solid state research are described. These are: the thermal neutron irradiation facility, the liquid helium cryostat, the position five facility, the liquid-nitrogen cooled cryostat, and the fast-flux irradiation facility. NSA

N67-32576 Oak Ridge National Lab., Tenn.
OAK RIDGE NATIONAL LABORATORY ANNUAL REPORT FOR 1966
1 Mar. 1967 98 p
(AR-1966) CFSTI: HC $3.00/MF $0.65

An annual report of the Oak Ridge National Laboratory is presented. The transuranium processing plant operations with radioactive materials are described and illustrated. Programs involving the molten-salt and gas-cooled reactors, thorium utilization, desalination, waste treatment and disposal, and nuclear safety are reviewed. Studies in the biological and physical sciences are reported. Information on the isotopes development center, civil defense, and technical information centers is also included. S.P.

N67-32648# Army Materials Research Agency, Watertown, Mass.
BERYLLIUM-FILTERED NEUTRON BEAM QUALITY FROM THE AMRR AS EFFECTED BY CORE ELEMENT ARRANGEMENTS
John J. Antal, and Albert A. Warnas Feb. 1967 28 p refs
(AMRA-TR-67#05; AD-652254) CFSTI: HC $3.00/MF $0.65

Neutron spectra in the region of 4 to 8 Angstroms were obtained for various fuel and BeO reflector arrangements in the Army Materials Research Reactor. Intensity and signal-to-noise ratio changes in the range of 15% to 20% were obtained at a single axis crystal spectrometer through rearrangement of core elements immediately adjacent to the beam tube termination. In general, the results indicate that the experiment external to the reactor should view reflector element material only, at the core face, and this reflector material should be surrounded by fuel for the best intensity and signal-to-noise combination. Spectral shift changes were found to be less than 4%. Some data on the removal of water from beam tube gaps are included in an appendix. Author (TAB)

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-31638# Israel Inst. of Tech., Haifa. Dept. of Mechanics.
THE PHYSICAL TENSOR AND APPLICATION Final Scientific Report, 1 Nov. 1965–31 Jan. 1967
Zvi Karni 28 Feb. 1967 57 p refs
(Grant AF-EOAR-66-19)
(TDM-67-6; AFOSR-67-1161; AD-652678) CFSTI: HC $3.00/MF $0.65

Differential invariants are constructed from the first tensor derivative applied to the position vector, for the undeformed and for the deformed media in space, multiplying an asymmetric second-order field tensor (stress), and the relations between them established. Techniques permitting the solution of tensor equations as absolute multilinear vector forms are applied to the singular and quasi-singular bilinear forms, to the quasi-singular and collinear 3-form, and to some quasi-singular bilinear forms in combination with vectors leading to homogeneous and inhomogeneous differential equations of the first order. The formulation of the electromechanical field equations is preceded by a discussion on the time rate of volume and surface elements in motion, and by the introduction of a spinning material derivative which permits the consideration of a multi-relative motion of a continuum element. The general balance in integral form is set up, with the introduction and definition of a flux derivative and a flux potential. The balance of mass, charge, magnetic flux, linear momentum, angular momentum, and energy, are established, leading to the field equations of the electromechanical continuum. TAB

N67-31649 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE PROPAGATION OF OSCILLATIONS OF THE TYPE OF A WAVE FILM OF QUANTIZED THICKNESS
V. M. Babich and T. S. Kravtsova [1967] 7 p ref. Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 31, no. 2, 1967 p 204–210

Formal solutions of the wave equation and the elasticity theory equations are considered which are essentially different from zero only in the neighborhood of some surface. Physically such solutions correspond to a wave field whose intensity is noticeably different from zero only near this surface. The reflection and refraction of these waves are described. The analysis of the problem for the scalar case includes the solution of the parabolic equation. In the mathematical solution to the problem, the conservation of energy law is considered, as well as the propagation of elastic oscillations of the wave film type. R.B.

N67-31657*# Northrop Corp., Newbury Park, Calif. Applied Research Dept.
A THEORETICAL STUDY OF ANTENNAS IN MOVING IONIZED MEDIA. PART I: THE RECEIVING AREA OF A DIPOLE ANTENNA IN A MOVING MEDIUM Final Report, May 1966–Jun. 1967
K. S. H. Lee Jun. 1967 32 p refs
(Contract NAS12-115)
(NASA-CR-86683) CFSTI: HC $3.00/MF $0.65 CSCL 20N

The receiving area of a dipole antenna immersed in a moving medium is calculated by employing Minkowski's electrodynamics of moving media together with the power conservation law. Approximate results accurate up to the first order in v/c are obtained, v being the speed of the medium and c, the vacuum speed of light. Two cases are studied in detail: in case 1 the moving medium is simple, and in case 2 the moving medium is an ionized gas (plasma). It is found that the receiving and transmitting patterns are identical in case 1 but not in case 2. In both cases the effect of the motion of a medium on the receiving characteristics of a dipole antenna is brought out explicitly in the receiving-area formula which is then compared with the corresponding one when the medium is at rest. Author

N67-31740* Volt Technical Corp., Washington, D. C.
ON THE REGIONS OF IMPOSSIBILITY OF MOTIONS IN THE PROBLEM OF THREE BODIES [V OBLASTYAKH NEVOZMOZNOSTI DVIZHENIY V ZADACHE TREKH TEL]
V. G. Golubeyev 28 Jun. 1967 6 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Astron. (Moscow), v. 174, no. 4, 1967 p 767–770
(Contract NAS5-12487)
(NASA-CR-86663; ST-CM-10632) CSCL 20K

The regions of impossibility of motions are defined for three bodies, along with the conditions for their existence and their fundamental properties, for the case, when the modulus of the moment vector of system's quantity motion, which is constant, is not zero. Author

N67-31792 Lockheed Missiles and Space Co., Palo Alto, Calif.
WAVE PROPAGATION IN BONDED MEDIA
G. A. Van Fo Fy [1967] 6 p refs Transl. into ENGLISH from Prikl. Mekhan. i Tekhn. Fiz. (USSR), v. 3, no. 4, 1967 p 24–29

Mathematical formulas are presented on the problem of wave propagation in an infinite viscoelastic medium bonded to identical elastic and viscoelastic circular fibers arranged in parallel. The fibers form a regular double-periodic structure of a bonded medium. The general case of plane wave propagation is investigated analogously. Approximate formulas for operators are presented to determine the dependence of the wave propagation velocities on the mechanical characteristics of the constitutive components, and to estimate the energy dissipation during vibrations of bonded media. On the basis of the formulas, it is possible to find the velocity of wave propagation for laminated structures in oriented glass-plastics. R.U.

N67-31835*# Northrop Corp., Newbury, Calif. Applied Research Dept.
A THEORETICAL STUDY OF ANTENNAS IN MOVING IONIZED MEDIA. PART II: THE COMPLEX DOPPLER EFFECT Final Report, May 1966–Jun. 1967
K. S. H. Lee Jun. 1967 36 p refs
(Contract NAS12-115)
(NASA-CR-85024) CFSTI: HC $3.00/MF $0.65 CSCL 20N

A theory of the complex Doppler effect of an oscillating electromagnetic source moving uniformly through a homogeneous dispersive medium is presented. The analysis is based on a method of asymptotic evaluation of a certain threefold Fourier integral. The theory presented and the results obtained in this paper generally differ from those already reported in the literature. To illustrate the effect a few special cases are worked out in detail. Author

N67-32119*# Chrysler Corp., New Orleans, La. Michoud Assembly Facility.
OPTICAL TECHNOLOGY APOLLO EXTENSION SYSTEM. PART II: DEFINITION OF WORK TASKS
27 Sep. 1966 76 p refs
(Contract NAS8-20256)
(NASA-CR-86808) CSCL 22A

Alternative technological developments for space optics required by the Apollo Extension System (AES) are discussed, and an overall development plan is presented in terms of proposed NASA objectives and needs through the 1970 decade. New experiments development and their integration into conceptual designs and mission profiles are considered, with reliability expressed in terms of the performance of the experiments. Conceptual spacecraft and subsystems were developed from which the experiments could be performed; and design aspects considered include structural and mechanical design, mass properties, stress and load analysis, control and stabilization, power system, data management, environmental control, crew accessories, and thermal control. Available resources were analyzed, and cost estimates were made. A broad commonality was found for the optical technology required for astronomy, meteorology, remote sensing of the earth, planetary observation, and space optical observations. M.W.R.

N67-32276# Aerospace Research Labs., Wright-Patterson AFB, Ohio.
THE ANALYSIS OF NOISY NON-LINEAR DEVICES BY MEANS OF GENERALIZED RANDOM PROCESSES
Donn G. Shankland Mar. 1967 24 p refs
(ARL-67-0048; AD-653182) CFSTI: HC $3.00/MF $0.65

The mathematical description of noise by means of Generalized Random Processes is presented. The effects on the noise distribution of linear filters (amplifiers) is discussed and related to conventional filter theory. The modification of the noise by a quadratic device is then treated, and this formalism is then applied to the analysis of the noise performance of a correlation detector and a conventional square-law detector. The conventional detector is shown to have a superior signal-to-noise ratio. Author (TAB)

N67-32279*# Rice Univ., Houston, Tex.
MOTION OF MAGNETIC FLUX THROUGH SUPERCONDUCTING STRIPS
W. V. Houston and D. R. Smith [1967] 19 p refs
(Grant NsG-6)
(NASA-CR-86981) CFSTI: HC $3.00/MF $0.65 CSCL 20C

A torsion pendulum was used to measure mechanically the energy dissipation occurring in strips and vacuum-deposited films of indium as a function of the velocity with which they moved through a magnetic field normal to their surfaces. No dissipation was observed either above or below T_c when the strips moved through a uniform field. Below T_c energy dissipation occurred in both the strips and the films when they moved through localized fields and was an order of magnitude greater than in the normal state. The energy loss below T_c contains a part proportional to the velocity and a velocity independent part. Author

N67-32471# Technische Hogeschool, Eindhoven (Netherlands).
ON A CLASS OF WAVE EQUATIONS
Lambertus Adrianus Peletier (Ph.D. Thesis) 16 May 1967 104 p refs
CFSTI: HC $3.00/MF $0.65

Presented is an analysis of one-dimensional waves which are governed by a set of linear first order partial differential equations of the hyperbolic type and subject to linear initial and boundary conditions. Focused on are those waves in which discontinuities in the wave-surface or some of its derivatives travel with finite speed. Two methods are described which can be applied to studies of stability. The normal mode approach which hinges

upon a discussion of the harmonic waves of the system; and the direct approach which studies the evolution of solutions by tracing them with time in a suitably chosen normal linear function space. Both methods aim essentially at solving, at least partially, a Cauchy problem in that they both ask whether or not an initial perturbation will grow with time. To decide this, it is assumed in the normal mode approach that the ensuing wave phenomenon may be decomposed into its normal modes, i.e., they form a complete set. In the direct method, a measure for the deviation of the solution from the equilibrium configuration is derived, and stability is understood as the property of a solution to remain as close to an equilibrium configuration for all positive time, after a sufficiently small perturbation. This definition of stability is Lyapunov's definition for discrete mechanical system, generalized to include continuous systems. The stability of the Cauchy and the mixed problem is discussed, using and comparing the two methods. In connection with the mixed problem, the concept of causality is sometimes introduced; thus, f(t) is considered the cause and u(x,t) the effect. In the solution presented $u(x,t)=0$ for $t<0$ is always causal. Implications of the accepted practice of considering only those solutions as causal which are stable as well, are discussed. S.C.W.

N67-32489# Army Cold Regions Research and Engineering Lab., Hanover, N. H.

RESONANCE CURVE ANALYSIS

R. K. Bernhard Mar. 1967 41 p refs

(CRREL-SR-97; AD-653144) CFSTI: HC $3.00/MF $0.65

Resonance curves, defining the relation between displacement, velocity, or power and exciter frequency are analyzed. A distinction is made between excitation by sinusoidal force vectors of constant amplitude and by vectors whose amplitudes increase with the square of the frequency. Both types are applied to one-degree-of-freedom systems with linear characteristics. Evaluation of these resonance curves to determine dynamic responses is discussed and followed up by some practical applications. Author (TAB)

N67-32507# Army Test and Evaluation Command, White Sands Missile Range, N. Mex.

POSITION FROM ANGLE MEASUREMENT Special Report

P. J. Short Jul. 1966 43 p ref

(RE-S-66-3; AD-653152) CFSTI: HC $3.00/MF $0.65

The position of an object in space is estimated from a set of angular measurements and certain axiomatic equations. The bases for the method are the Principle of Least Squares and Euclidean spatial geometry. Author (TAB)

N67-32594*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

RADIOMETRY PROGRESS FIRST TRIMESTER, 1967

Apr. 1967 172 p refs

(NASA-TM-X-55827; X-713-67-126) CSCL 20F

CONTENTS:

1. DIGEST Charles H. Duncan 8 p refs

2. THERMAL LABORATORY, SECTION II QUARTERLY PROGRESS REPORT, 1 DEC. 1966–28 FEB. 1967 M. Lillywhite, O. Olesen, D. Lester, G. Enos, L. Hallman et al (Electro-Mech. Res., Inc.) 17 p (See N67-32595 18-03)

3. ARC RESEARCH, SECTION III S. M. Neuder 3 p (See N67-32596 18-25)

4. ELECTROMAGNETIC MEASUREMENTS QUARTERLY PROGRESS REPORT, 1 DEC. 1966–28 FEB. 1967 R. McIntosh, R. Urschel, D. Mosier, R. Stair, and S. Hall (Electro-Mech. Res., Inc.) 31 p (See N67-32597 18-25)

5. SPECTRAL IRRADIANCE MEASUREMENTS, SECTION V M. J. Brown (Electro-Mech. Res., Inc.) 36 p (See N67-32598 18-23)

6. CONVAIR 990 FLIGHT EXPERIMENT, SECTION VI J. J. Webb 4 p (See N67-32599 18-14)

7. COATINGS QUALITY ASSURANCE, SECTION VII A. J. Hobbs and B. Seidenberg 18 p (See N67-32600 18-17)

8. COATINGS DEGRADATION, SECTION VIII C. A. Nicoletta 20 p (See N67-32601 18-18)

9. EVALUATION OF SEVERAL INTENSE LIGHT SOURCES USED FOR ACTINISM STUDIES, APPENDIX I M. Lillywhite, R. McIntosh (Electro-Mech. Res., Inc.), C. Duncan, and J. Colony 12 p refs (See N67-32602 18-23)

10. ULTEK TRIP REPORT 4 p (See N67-32603 18-34)

11. QUALITY ASSURANCE LABORATORY, APPENDIX III 3 p (See N67-32604 18-15)

N67-32598*# Electro-Mechanical Research, Inc., College Park, Md. Aerospace Sciences Div.

SPECTRAL IRRADIANCE MEASUREMENTS, SECTION V

M. J. Brown *In* NASA. Goddard Space Flight Center Radiometry Progr. 1st Trimester, 1967 Apr. 1967 36 p (See N67-32594 18-23)

(Contract NAS5-3743)

Optical characteristics and spectral irradiance of three solar simulation lamps during extended operating times to approximately 600 hours were measured. The degree of degradation in intensity of the lamps was significant, although tolerable, for most applications. The spectral distribution from one lamp to another was quite uniform and predictable. Author

N67-32602*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

EVALUATION OF SEVERAL INTENSE LIGHT SOURCES USED FOR ACTINISM STUDIES, APPENDIX I

Malcolm Lillywhite, Roy McIntosh (Electro-Mech. Res., Inc.), Charles Duncan, and Joe Colony *In its* Radiometry Progr. 1st Trimester, 1967 Apr. 1967 12 p refs (See N67-32594 18-23)

Several sources used for space environment solar simulation testing were evaluated in terms of (1) their operational characteristics, and (2) the effects of their different spectral irradiance characteristics on several thermal control coatings. Nine sources are discussed: Xe, filtered Xe, HgXe, Kr, Ar, H–Xe, 2.5 kw compact short arc lamps, a medium pressure 500-watt Hg vapor lamp, a carbon arc, and an Ar-filled experimental vortex arc lamp. The coatings used are commercially available white paints commonly used on satellites. The spectral irradiance characteristics of the sources are discussed in terms of degree of solar spectral mismatch, effective absorptance values of each coating, and rate and magnitude of the degradation. The results of short term (<200 hours) testing of these coatings, irradiated with different sources, show that for some coatings large errors may result from the use of solar spectral mismatch and for others the rate of degradation is different, but the ultimate absorptance value achieved through degradation may not be significantly affected. The "actual absorptance" value is obtained using an optical "in-situ" measurement and the "effective absorptance" values are computed using the relative spectral reflectance of the coating and the spectral irradiance of the source. Author

N67-32650# Ohio Univ., Athens. Dept. of Physics.

THE STUDY AND USE OF COMPLAINT TUBES TO INFLUENCE THE ACOUSTIC INTERACTION BETWEEN SMALL TRANSDUCERS AT AN AIR–WATER SURFACE Annual Summary Report

F. B. Stumpf and L. A. Crum 1 Jun. 1967 107 p refs

(Contract Nonr-4419(01))

(ASR-3; AD-652578) CFSTI: HC $3.00/MF $0.65

The report describes measurements of the radiation impedance as influenced by acoustic interaction for two small magnetostrictive hairpin stack transducers at an air-water surface. In particular, the effect of thin-metal compliant-tube arrays on the acoustic interaction

impedance was investigated for various geometries. These tubes, which were made of flattened hollow aluminum tubes, have been suggested by W. J. Toulis in order to influence the acoustic interaction among sonar array elements. It has been found that compliant tubes can be constructed and used in this way to influence the interaction impedance. The purpose of the study is to lead to design criteria for more efficient sonar arrays which include compliant tubes. Author (TAB)

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-31540# Oak Ridge National Lab., Tenn.
SOME PRELIMINARY CONSIDERATIONS TO THE NEUTRON ELECTRIC DIPOLE MOMENT EXPERIMENT AT ORNL: INCLUDING A SUMMARY OF SYMMETRY PRINCIPLES FOR ELEMENTARY PARTICLES
W. B. Dress Mar. 1967 63 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1754) CFSTI: HC $3.00/MF $0.65

A review of the discrete symmetries of particle physics is given, and some of the more important experiments establishing the violations of these symmetries are discussed. The need for a new measurement of the electric-dipole moment of the neutron is suggested. The neutron spectrum obtained from a bent neutron conducting tube as a function of various experimental parameters is described. The transition probability for split-coil magnetic resonance spectrometer is derived; this probability is then averaged over the neutron spectrum obtained in the bent conducting tube. The design problems of the required electric and magnetic field are also considered in detail. Author (NSA)

N67-31551 European Nuclear Energy Agency, Paris (France).
NEUTRON DATA COMPILATION CENTER NEWSLETTER NO. 5
Apr. 1967 72 p refs
(CCDN-NW/5)

Presented is a compilation of evaluated neutron data relevant to development of nuclear energy. The criteria for inclusion were that the material should be generally available, that it should give a complete set of data for input to neutronics calculations, and that full documentation should be provided in support of the evaluation. The following information is given for each nuclide material: energy range; data of evaluation; laboratory making evaluation; publication references; media in which data are available; data bank; reactions considered; and comments. K.W.

N67-31656*# California Univ., Los Angeles. Dept. of Engineering.
EXPERIMENTAL STUDY OF SCATTERING IN ATOM-SURFACE COLLISIONS WITH ATOM ENERGIES OF THE ORDER OF eV
Jack Alcalay Jun. 1967 133 p refs
(Grants NaG-237-62; NSF GP-534; NSF GK-580)
(NASA-CR-86653; Rept.-67-20) CFSTI: HC $3.00/MF $0.65
CSCL 20H

Measurement of flux distributions of the scattered molecular flow field when a 1 eV supersonic argon beam impinges on various surfaces is discussed. The experimental methods and results are described with emphasis on the dynamics of the incident and scattered molecular flow fields. The modulation and time-of-flight methods are examined, and relationships between the moments of a class of speed distribution functions and those of their time-domain analogues are examined. The detection process and design and operation of a new type of ionization detector developed for these experiments is described. A novel dynamic calibration concept is applied in characterizing the role of the detector in the experiment. Finally scattering results are discussed. S.P.

N67-31639# Los Alamos Scientific Lab., N. Mex.
QAD: A SERIES OF POINT-KERNEL GENERAL-PURPOSE SHIELDING PROGRAMS
Richard E. Malenfant 5 Apr. 1967 195 p refs
(Contract W-7405-ENG-36)
(LA-3573) CFSTI: HC $3.00/MF $0.65

QAD is the generic designation for a series of point-kernel computer programs designed for estimating the effects of gamma rays and neutrons that originate in a volume-distributed source. Gamma ray dose rates, energy depositions, uncollided fluxes, and associated quantities; as well as interpolated moments-method neutron fluxes, energy depositions, and dose rates, may be calculated. Surfaces, defined by quadratic equations, are used for a three-dimensional description of the physical situation. Speed, flexibility, and ease of use, as well as the ability to mockup any direct-beam radiation problem, contribute to the utility of the program. Author (NSA)

N67-31646 Forsvarets Forskningsanstalt, Stockholm (Sweden).
AN ENERGY-WEIGHTED M1 SUM RULE
G. Arbman Mar. 1966 26 p refs
(FOA-4-A-4475-411)

An energy-weighted M1 transition sum rule for nuclei is constructed, using shell model jj-coupled wave functions. The sum is compared to the model-independent energy-weighted E1 sum, and calculated for spherical nuclei in the region $58 \leq A \leq 210$. Author

N67-31665# Stanford Univ., Calif. Linear Accelerator Center.
TEUTA—KINEMATICAL ANALYSIS PROGRAM FOR COLLIDING BEAM EVENTS
I. Derado and R. Leedy Feb. 1967 30 p refs
(Contract AT(04-3)-515)
(SLAC-72) CFSTI: HC $3.00/MF $0.65

TEUTA is a Fortran IV program that does kinematical analysis of events with correlated moments, such as events without a visible vertex. Incoming, outgoing, and target particles are all treated as four-component vectors (m_i, $1/p_i$, λ_i, ϕ_i) thus allowing TEUTA to be used for colliding beam, unknown target particle, and disintegrating particle experiments with no program changes. TEUTA is written in subroutine form where everything is kept as simple as possible so that the user need supply only the peripheral routines necessary to blend TEUTA into his system. The additional peripheral programs described were developed at SLAC for streamer chamber data analysis. To use TEUTA one must first supply data describing an event in the form of two adjoint four-vector arrays, P_i^m and I_i, and full correlation error matrix, G_{ij}. The P_i^m array contains m_i, $1/p_i$, λ_i, ϕ_i, and the I_i array contains integers that tell if the P_i^m data is fixed, measured, or unknown. Then one may supply any number hypotheses consisting of lists of fixed masses preceded by plus or minus signs to depict incoming and outgoing particles. TEUTA calculates new "best values," P_i^n, such that energy and momentum are conserved and the expression $(P_i^m - P_i^n)\, G_{ij}^{-1} (P_j^m - P_j^n)$ is minimized. Author (NSA)

N67-31678 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
HALL MOBILITY ANNEALING IN ELECTRON IRRADIATED GERMANIUM
A. Jaworowski, H. Rzewuski, and Z. Warner Dec. 1966 9 p refs
(INR-771/II/PL)

Isochronal annealing of Hall mobility changes in Sb-doped germanium after 1 MeV electron irradiation was studied in the temperature range of 90–230°K. Two annealing stages have been observed, one at 100°K and the second (related to the recovery of about 50% of changes induced by irradiation) at 135°K. No carrier concentration recovery has been observed in this temperature range. The latter stage corresponds with the stage found already for gamma irradiation, while the former one seems to be related to some contact annealing. Author

N67-31706*# Naval Radiological Defense Lab., San Francisco, Calif.
ANGULAR DISTRIBUTIONS AND ENERGY SPECTRA OF ELECTRONS TRANSMITTED THROUGH AND REFLECTED FROM ELEMENTAL FOILS
Bruce W. Shumway, William E. Kreger, and Ralph M. Brown 6 Sep. 1966 44 p refs
(NASA Order R-142)
(NASA-CR-85978; USNRDL-TR-1069; AD-640865) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Experimental electron energy spectra at various angles of emergence or reflection from foils of carbon, aluminum, copper, silver, and gold have been measured. Thicknesses used ranged from 0.2 to 0.6 of the electron range. In all cases the incident radiation was a broad, monodirectional, monoenergetic electron beam perpendicular to the foil. Beam energies were 0.5, 0.75, 1.0, 1.5, and 1.95 MeV. The spectrometer used an anthracene crystal as the detector. Author

N67-31708# Argonne National Lab., Ill.
ON THE SHIELDING OF THE EXTERNAL PROTON TUNNEL AREA OF ARGONNE'S ZERO GRADIENT SYNCHROTRON
G. V. Oldfield (Univ. of Mich.), H. J. Howe, D. J. Sreniawski, and R. V. Wheeler Nov. 1966 22 p refs
(Contract W-31-109-ENG-38)
(ANL-7273) CFSTI: HC $3.00/MF $0.65

An experimental evaluation of the radiation levels in the area of the external proton tunnel (EPT) of the Argonne Zero Gradient Synchrotron (ZGS) under conditions of thick-target bombardment by approximately 2×10^{10} protons/sec has been completed. The radiation levels in the forward hemisphere from the target varied linearly with target thickness, and the maximum levels were observed between 60 and 70° from the incident beam direction. A reduction of radiation levels noted at smaller angles ($\theta < 40°$) is attributed to the longer path length of shield materials traversed by secondaries emitted into the forward direction. A similar reduction of radiation levels observed at large angles ($\theta > 75°$) is attributed to the smaller number of high-energy secondaries emitted from the target into these directions. The dependence of the radiation levels on distance from the shield wall was found to consist of an area of rapid decrease (approximately as $1/r^2$) followed by an area of less rapid decline (approximately as $1/r$). Measurements of the stray radiation field with tissue-equivalent (TE) ionization chambers in normally occupied areas indicated absorbed dose levels of 0.2 to 0.8 mrad/hr with a 0.5-in. copper target and 0.3 to 3.0 mrad/hr with a 5.0-in. copper target. With an effective quality factor (QF) of 5, determined from experimental linear energy transfer (LET) spectral measurements, these measurements yield dose equivalent rates (DE) from 1.0 to 4.0 mrem/hr with the 0.5-in. target and from 1.5 to 15.0 mrem/hr with the 5.0-in. target. Hence, it was necessary to revise the shielding configuration to obtain more effective attenuation without a significant reduction of experimental space. By means of a simple exponential attenuation model, the data were used to obtain estimates of the attenuation lengths λ_s and λ_c for steel and concrete, respectively. These estimates: $\lambda_s = 142 \pm 15$ g/cm^2 ($\rho = 7.85$ g/cm^3) and $\lambda_c = 173 \pm 18$ g/cm^2 ($\rho = 2.8$ g/cm^3), are in fair agreement with previously published results. Since accurate and reliable shielding calculations depend on the accuracy of these parameters, a more extensive evaluation of the shielding properties of ordinary concrete, high-density concrete, and steel is planned for the purpose of obtaining definitive values of λ_s and λ_c for the ZGS shielding materials. Author (NSA)

N67-31715# Los Alamos Scientific Lab., N. Mex.
KILOVOLT EUROPIUM CAPTURE CROSS SECTIONS
Donald W. Barr and Joseph J. Devaney 7 Apr. 1967 51 p refs
(Contract W-7405-ENG-36)
(LA-3643) CFSTI: HC $3.00/MF $0.65

Estimates of the europium radiative capture cross sections for neutrons are given for ^{151}Eu, ^{152}Eu, ^{153}Eu, ^{154}Eu, and ^{155}Eu. These calculations utilize the slope of the total cross section, resonance parameters, known odd–even versus odd–odd behavior, and theory. They are compared with experimental values derived from the nuclear device "Cyclamen" and from direct measurement. Author (NSA)

N67-31722 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Physics.
PARTIAL HALF-LIVES OF ALPHA DECAY OF ^{151}Tb AND ^{149}Tb NUCLEI
Jan Kormicki, Henryk Niewodniczanski, Zbigniew Stachura, Kazimierz Zuber, and Alioja Budziak Mar. 1967 19 p refs
(Rept.-535/PL)

Alpha branching ratios were measured and partial half-lives of alpha decay were determined for Tb 151 and Tb 149 nuclei. The alpha branching ratios were obtained by determining the ratio of intensity of suitable electron conversion lines in Gd and Eu nuclei produced from Tb 151 and Tb 149 nuclei by electron capture and alpha decay respectively. The values obtained for the alpha branching ratios are $(5 \pm 1.5) \times 10^{-6}$ for Tb 151, and $(2 \pm 0.8) \times 10^{-1}$ for Tb 149. Alpha reduced widths δ^2 and hindrance factors F were calculated. Author

N67-31823# Argonne National Lab., Ill.
STOCHASTIC PROBLEMS IN TRANSPORT THEORY
Peter John Brockwell Aug. 1966 142 p refs
(Contract W-31-109-ENG-38)
(ANL-7131) CFSTI: HC $3.00/MF $0.65

The application of the theory of discontinuous Markov processes and stochastic population processes to problems in the field of transport theory is investigated. It is shown how a scattering process (in which there may, at each collision, be a constant probability that the scattered particle is absorbed and lost to the system) can be characterized by transition probabilities $P_k(S; \theta_1, \ldots, \theta_k | \omega; s)$ of a transition $\omega \to S$ in distance s with exactly k scatterings, the angles of scattering $\theta_1, \ldots, \theta_k$ (in order of occurrence) being such that $\theta_1 \in \Theta_1, \ldots, \theta_k \in \Theta_k$. Such a characterization is of importance when there is a change of state of the particle at each collision and the corresponding transition probabilities depend on the angle of deflection. For one-dimensional processes the problems simplify considerably owing to the fact that the angular deflections θ_i can take only two values, 0 or π. A detailed investigation of one-dimensional problems in which the probability of a collision in a small element of path length δs is $\lambda \delta s + o(\delta s)$ is made. In order to apply the theory of scattering in three dimensions, an approximation is made in which scattered particles are assumed to move in one of a set of 30 directions in space. This model is considered in detail. A particular one-dimensional problem which arises in the analysis of bubble chamber tracks and is concerned with the stochastic population process generated by the distances traveled between successive collisions in a fixed length of track is considered. One-dimensional processes in which the distances traveled by a particle between successive collisions have either a gamma distribution or a distribution which is a linear combination of negative exponential distributions are discussed.

Processes of the latter kind can be used to improve the approximation (used by Fermi and others) to the projection on a fixed axis of the three-dimensional motion of a particle which is scattered isotropically. Multiplicative scattering processes in one dimension are also considered. Several mathematical models for one-dimensional neutron multiplication in a rod are considered, with particular reference to the concept of criticality and the distribution of the number of emergent neutrons produced by a single trigger neutron. Author (NSA)

N67-31913# Yale Univ., New Haven, Conn. Gibbs Lab.
ANNUAL SUMMARY REPORT, APRIL 1, 1966–DECEMBER 31, 1966
Vernon W. Hughes Jan. 1967 9 p refs
(Contract Nonr-609(53))
(AD-646830) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ATOMIC BEAM SOURCE OF POLARIZED ELECTRONS V. W. Hughes, M. S. Lubell, M. Posner, and W. Raith 6 p (See N67-31914 18-24)

2. THE MAGNETIC MOMENT AND HFS ANOMALY FOR HELIUM-3 W. L. Williams and V. W. Hughes 9 p refs (See N67-31915 18-24)

N67-31914# Yale Univ., New Haven, Conn. Gibbs Lab.
ATOMIC BEAM SOURCE OF POLARIZED ELECTRONS
V. W. Hughes, M. S. Lubell, M. Posner, and W. Raith *In its* Ann. Sum. Rept., Apr. 1, 1966–Dec. 31, 1966 Jan. 1967 6 p (See N67-31913 18-24)

Details are given on a polarized electron source which operates with an atomic beam of lithium 6. A pulsed light source is used due to the high ionization potential of lithium, corresponding to a threshold wavelength of 2300 Å. This light source is a high pressure spark between tungsten electrodes; optical components are placed in a vacuum chamber; front surface mirrors coated with MgF_2 are used; and the windows are made of LiF so that all the light between the ionization threshold and the LiF cutoff at 1150 Å can be used for the photoionization. The apparatus has a built-in hot wire detector which can be moved into the atomic beam, and the oven can be moved horizontally and vertically under operation. Preliminary atomic beam intensity measurements gave 10^{16} atoms/sec beyond the polarizing six-pole magnet; initial photoelectron intensity measurements gave 3×10^{7} electrons per pulse. M.G.J.

N67-31915# Yale Univ., New Haven, Conn. Gibbs Lab.
THE MAGNETIC MOMENT AND HFS ANOMALY FOR HELIUM-3
W. L. Williams and V. W. Hughes *In its* Ann. Sum. Rept., Apr. 1, 1966–Dec. 31, 1966 Jan. 1967 9 p refs (See N67-31913 18-24)

A nuclear magnetic resonance absorption experimental technique is described, which resulted in a high precision measurement of the magnetic moment of He^3 to a precision of 0.1 ppm, which represents an improvement by a factor of 10 relative to an earlier measurement. From this new value for $\mu(He^3)$ together with the value of the hyperfine-structure interval for He^3 in the ground $1\ ^2S_{1/2}$ state of He^+, a more accurate value for the HFS anomaly, δ_{He^3}, for He^3 is determined. Author

N67-31961# Comitato Nazionale per l'Energie Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
REPORT PRESENTED AT INTERNATIONAL SYMPOSIUM ON ELECTRON AND POSITRON STORAGE RINGS, PART II
15 Nov. 1966 38 p refs Symposium held in Saclay, France, Sep. 1966 *Its* Note Interne 337
(LNF-66/56) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. PROJECT OF AN EXPERIMENT ON e^+e^- ANNIHILATION IN TWO BOSONS M. Grilli, V. Manno, F. Soso, P. Spillantini, R. Visentin et al p 3–13 ref (See N67-31962 18-24)

2. SINGLE BOSON PRODUCTION IN ADONE B. Bartoli, C. Bernardini, F. Felicetti, V. Silvestrini, A. Goggi et al p 15–24 refs (See N67-31963 18-24)

3. PROJECT OF AN $e^+e^- \rightarrow \gamma+\gamma$ OR $\pi^0+\gamma$ EXPERIMENT AT ADONE G. Capon, G. P. Murtas, C. Pellegrini, A. Reale, M. Spinnetti et al p 25–36 refs (See N67-31964 18-24)

N67-31962# Comitato Nazionale per l'Energie Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
PROJECT OF AN EXPERIMENT ON e^+e^- ANNIHILATION IN TWO BOSONS
M. Grilli, V. Manno, F. Soso, P. Spillantini, R. Visentin et al *In its* Rept. Presented at Intern. Symp. on Electron and Positron Storage Rings, Part II, 15 Nov. 1966 p 3–13 ref (See N67-31961 18-24)

An apparatus incorporating plastic scintillators, a Cerenkov counter, and spark chambers, used for the positron electron annihilation experiment, is described. General criteria for the discrimination between the different particles produced (muons, pions, and kaons); and the electronic masters that will be used for selecting the reactions $e^+e^- \rightarrow \pi^+\pi^-$ and $e^+e^- \rightarrow K^+K^-$ in different ranges of energy, are discussed. The electronic masters to be used for reactions $e^+e^- \rightarrow K^+K^-$ and $e^+e^- \rightarrow K_1^0K_2^0$ in the ϕ region, where E = 507–520 MeV, are also described. L.S.

N67-31963# Comitato Nazionale per l'Energie Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
SINGLE BOSON PRODUCTION IN ADONE
B. Bartoli, C. Bernardini, F. Felicetti, V. Silvestrini, A. Goggi (Pavia Univ.) et al *In its* Rept. Presented at Intern. Symp. on Electron and Positron Storage Rings, Part II, 15 Nov. 1966 p 15–24 refs (See N67-31961 18-24)

The experimental setup for using the Adone mass spectrometer (mass range goes up to 3 BeV, twice the maximum energy of each primary electron) for studying the single bosons produced in e^+e^- collisions, is described. A simple detection system accepting both charged products and γ rays is depicted. A fast method of exploring the whole mass range by continuously varying the energy of the storage ring from the minimum to the maximum, is described. The main virtue of the method is that intense single boson lines will be simultaneously evident after a short running time wherever they are in the scanned mass range. Smaller bumps will gain statistical significance as time goes on. A crude sketch of the expected plot (cross section vs energy) is depicted. Counting rate estimates are given, and approximations of the nonresonant background are made. L.S.

N67-31964# Comitato Nazionale per l'Energie Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati.
PROJECT OF AN $e^+ + e^- \rightarrow \gamma+\gamma$ OR $\pi^0+\gamma$ AT ADONE
G. Capon, G. P. Murtas, C. Pellegrini, A. Reale, M. Spinetti et al *In its* Rept. Presented at Intern. Symp. on Electron and Positron Storage Rings, Part II, 15 Nov. 1966 p 25–36 refs (See N67-31961 18-24)

An experimental apparatus used for detecting the products $\gamma\gamma$ (photons) and $\pi^0\gamma$ (neutron pion and photon) of proton annihilation reactions in the electron positron storage ring Adone, is described. The apparatus consists of 4 spark chambers at 90° to the electron beam and two others, called monitor chambers, at small angles. The first chambers were used to measure the angular distribution between 45° and 135°, while the monitor chambers were used to measure the cross section at 0.25°. Results of some measurements are presented. Calculations regarding the cross sections are given. L.S.

N67-32025# Los Alamos Scientific Lab., N. Mex.
TIME-OF-FLIGHT NEUTRON CROSS SECTION MEASUREMENTS USING NUCLEAR EXPLOSIONS (PART II)
P. A. Seeger and D. W. Bergen 20 Mar. 1967 38 p refs
(Contract W-7405-ENG-36)
(LA-3478, Pt. II) CFSTI: HC $3.00/MF $0.65

The procedures used for converting analog (film) records of data obtained from the interaction of nuclear-device-produced neutrons with target nuclei to cross sections as a function of neutron energy are described. A discussion of the errors is also presented. The conversion procedures include digitizing the records; converting all data to signal vs time; deriving a background to be subtracted from all signals; deriving a flux based on the known cross section of a foil isotope; and obtaining the cross section by converting signal to reaction rate and dividing by the flux and foil density. Author (NSA)

N67-32033*# Volt Technical Corp., Washington, D. C.
NUCLEAR TRANSFORMATIONS IN NATURE [YADERNYYE PREVRASHCHENIYA V PRIRODE]
N. A. Vlasov 26 Jun. 1967 7 p refs Transl. into ENGLISH from At. Energ. USSR (Moscow), v. 5, no. 22, 1967 p 339–342
(Contract NAS5-12487)
(NASA-CR-86637; ST-NP-CG-10630) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Instability boundaries of nuclei relative to the emission of protons and neutrons, and the conditions of existence in nature of neutron-surplus nuclei close to instability boundary are discussed. Assumed collisions of material cosmic bodies with antimatter are used to explain some of the anomalies in the distribution of elements and isotopes. Author

N67-32121*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
ANGULAR DISTRIBUTION OF THICK-TARGET BREMSSTRAHLUNG WHICH INCLUDES MULTIPLE ELECTRON SCATTERINGS
W. Wayne Scott Washington, NASA, Aug. 1967 35 p refs
(NASA-TN-D-4063) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A theoretical analysis which includes multiple electron scattering as described by a random-walk procedure is presented for predicting the spectrum of bremsstrahlung produced at angles relative to a monoenergetic flux of electrons of normal incidence on thick targets. The assumption is made that the spectral and angular distribution of radiation leaving a thick target can be considered to be the sum of the contributions from a series of thin strips, one behind the other, bombarded by electrons of continuously decreasing energy. The following processes are considered in the analysis: (1) radiation of electrons in thin targets as predicted by the Bethe–Heitler theory; (2) electron penetration into the target which includes (a) multiple electron scattering as predicted by Goudsmit–Saunderson theory, (b) electron backscatter out of the target, (c) electron energy loss in the target, and (d) electron–electron bremsstrahlung; and (3) the absorption and buildup of photons in the target. Comparisons are made between the calculated results and experimental data for aluminum and iron thick targets. On the whole the agreement is reasonably good. Author

N67-32300# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACADEMY OF SCIENCES. COMMISSION OF SPECTROSCOPY MATERIAL OF THE 13TH CONFERENCE "PHYSICAL PROBLEMS OF SPECTROSCOPY"—SELECTED ARTICLES
12 Dec. 1966 18 p refs Transl. into ENGLISH from "Fizicheskiye Problemy Spektroskopii, No. 2" Moskow, Izd. AN SSSR, 1963 p 96–112
(FTD-MT-66-368; TT-67-61122; AD-647714) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. CROSS RELAXATION DUE TO HYPERFINE INTERACTIONS G. F. Mekhtiyev p 1–4 refs (See N67-32301 18-24)

2. STUDY OF THE PROPERTIES OF HYDROGEN ATOMS ABSORBED ONTO A SILICA-GEL SURFACE BY THE METHOD ELECTRON PARAMAGNETIC RESONANCE V. B. Kazanskiy, G. B. Pariyskiy, V. V. Voyevodskiy, and A. I. Burshteyn p 5–11 refs (See N67-32302 18-24)

N67-32301# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CROSS RELAXATION DUE TO HYPERFINE INTERACTIONS
G. F. Mekhtiyev *In its* Acad. of Sci. 12 Dec. 1966 p 1–4 refs (See N67-32300 18-24)

This article discusses cross relaxation resulting from hyperfine interactions. Spin levels with a hyperfine structure are assumed. Under hyperfine interactions flip-flop transitions can occur between hyperfine levels, which belong to different fine component levels of the spectrum. Hyperfine interaction in tuttonic salt of copper is cited. Author

N67-32302# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
STUDY OF THE PROPERTIES OF HYDROGEN ATOMS ABSORBED ONTO A SILICA-GEL SURFACE BY THE METHOD ELECTRON PARAMAGNETIC RESONANCE
V. B. Kazanskiy, G. B. Pariyskiy, V. V. Voyevodskiy, and A. I. Burshteyn *In its* Acad. of Sci. 12 Dec. 1966 p 5–11 refs (See N67-32300 18-24)

In recent years spectroscopic methods are being used more and more in the study of properties of absorbed molecules and the mechanism of catalytic reactions. Special interest is afforded by the study of the properties of intermediate products of catalytic reactions, which, as is often supposed, can have the character of free radicals, whose properties are well studied in gases and in the liquid phase. A method with good prospects for studying free radical properties is the electron paramagnetic resonance method. Unfortunately, the insufficient sensitivity of this method still does not enable making studies on the properties of the active intermediate processes in the course of catalytic reactions. Therefore it was found interesting to study the properties of the intermediate compounds whose formation is assumed in catalytic reactions, which can be attained by an independent method. Author

N67-32316# Illinois Univ., Urbana. Dept. of Physics.
ABSORPTION MODEL ANALYSIS OF KN → K(890)N REACTIONS
John T. Donohue [1967] 39 p refs
(Contract N00014-67-A-0305-0005)
(AD-652826) CFSTI: HC $3.00/MF $0.65

The absorptive peripheral model using a mixture of pion and vector meson exchange is used to analyze data on K (plus or minus) p to K* (plus or minus) (890)P at momenta approx. = 3 GeV/c. The vector meson exchange couplings are obtained phenomenologically by fitting the experimental data. Good fits are obtained; in particular, evidence is found for an interference effect between pion and vector meson exchange which causes difference between K*(+) and K*(-) reactions. The production of neutral K* is discussed, and an attempt is made to separate the I = 0 and I = 1 vector meson exchanges. Some predictions of the model for higher energies are presented, which suggest that the known energy dependence difficulties of vector meson exchange will make our method inapplicable. Evidence for the interference effect in other reactions is suggested, and experimental tests are proposed. Author (TAB)

N67-32323*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SEARCH FOR THE γ-2γ PROCESS IN NUCLEAR ELECTROSTATIC FIELDS

William K. Roberts and David C. Liu Washington, NASA, Aug. 1967 29 p refs

(NASA-TM-X-1403) CFSTI: HC $3.00/MF $0.65 CSCL 20H

An experiment designed to detect the γ-2γ process (an interaction of a photon with an electric field with the subsequent emission of two photons) was performed. A geometry was chosen in which the secondary gamma rays were emitted at an angle of 90° to each other and at an angle of 135° to the projection of the incident gamma ray arrival direction. Measurements were performed by using lead and copper targets and 1.33-MeV (2.14×10^{-13}J) primary gamma rays. An energy-summing time-coincidence technique was employed to detect pairs of secondary gamma rays. Statistically significant upper limits of 960 nanobarns per steradian squared per MeV (6×10^{-22} $m^2/(sr^2)(J)$) for the differential cross section in lead and 146 nanobarns per steradians squared per MeV (0.915×10^{-22} $m^2/(sr^2)(J)$) in copper were obtained, comparing with theoretical values of 0.8 and 0.1 nanobarn per steradian squared per MeV (0.5×10^{-24} and 0.062×10^{-24} $m^2/(sr^2)(J)$), respectively, for this geometry. Although the upper limits established herein did not become a rigorous test of the theory, information gained from this experiment indicates that cross sections in the range of theoretical predictions can be measured with suitable improvements of the experimental technique. These improvements are discussed herein. Author

N67-32341# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

[NUCLEAR PHYSICS WORK] [JAHRESBERICHT 1966]

Annual Report, 1966

W. Hering, ed. 1966 228 p refs In GERMAN

(AR-3)

CONTENTS:

1. ANNUAL REPORT OF TANDEM LABORATORY p 3–118 refs (See N67-32342 18-24)

2. ANNUAL REPORT (1965–1966) OF THE COSMOCHEMISTRY DIVISION p 119–158 refs (See N67-32343 18-30)

3. ANNUAL REPORT OF THE NUCLEAR SPECTROSCOPY WORK GROUP p 159–166 refs (See N67-32344 18-24)

4. ANNUAL REPORT OF CYCLOTRON LABORATORY p 167–181 refs (See N67-32345 18-24)

5. ANNUAL REPORT OF THE MAX-PLANCK-INSTITUT VISITORS AT THE KARLSRUHE NUCLEAR RESEARCH CENTER p 182–190 refs (See N67-32346 18-24)

6. ANNUAL REPORT OF THE MAX-PLANCK-INSTITUT VISITORS AT CERN p 191–211 refs (See N67-32347 18-24)

N67-32342# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

ANNUAL REPORT OF TANDEM LABORATORY [JAHRESBERICHT DES TANDEMLABORS]

In its [Nucl. Phys. Work] 1966 p 3–118 refs (See N67-32341 18-24)

Operations and experiments conducted on the tandem accelerator are reported. The routine acceleration of lithium ions was added to existing experiments. There was no need to replace the accelerator tubes after a total of 14,682 hrs of operation. Summaries are presented of reaction experiments with heavy ions. Transfer reactions with light particles that were studied included reactions with He 3 and tritons, the dependence on angular distribution, stripping reactions with deuterons, and stripping reactions at low energies. Structural measurements were performed in excitation functions. Elastic scattering, angular distribution, and lifetime values were determined for several light nuclei. The development of measuring techniques and devices is reported, which includes scattering chambers, ion sources, experiments with semiconductors and particle penetration of crystals, computer development, and target material studies. Briefly covered are also studies of collective nuclei states, one-particle functions in light nuclei, particle reaction models, the structure of fluctuations, and the charge exchange of pi mesons on complex nuclei. Transl. by K.W.

N67-32344# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

ANNUAL REPORT OF THE NUCLEAR SPECTROSCOPY WORK GROUP [JAHRESBERICHT DER ARBEITSGRUPPE KERNSPEKTROSKOPIE]

In its [Nucl. Phys. Work] 1966 p 159–166 refs (See N67-32341 18-24)

Described is the use of a high-resolution beta spectrometer to determine the absolute values v/c, p/mc, or E/mc^2 of conversion electrons; to measure energy and intensity of conversion lines in the decay of Ir 192→Pt 192 and Se 75→As 75; to determine the influence of shielding effects on the M conversion coefficients; and to determine neutrino properties and form of the beta spectrum. Results of two experiments are given in which the beta–gamma circular polarization correlations of Co 60 and Na 22 were measured. Briefly reported are also spectrometer resolution tests and a computer program for evaluating conversion electron spectra. Transl. by K.W.

N67-32345# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

ANNUAL REPORT OF CYCLOTRON LABORATORY [JAHRESBERICHT DES ZYKLOTRONLABORS]

In its [Nucl. Phys. Work] 1966 p 167–181 refs (See N67-32341 18-24)

Measurements of the angular distribution of elastic and inelastic deuteron scatterings were performed on very light nuclei and on Ti 46, 48, and 50. Experiments on a 20-cm scattering chamber were conducted with 11.8 MeV deuterons to determine the spin-flip portion of the (d,d') reactions on Mg 24 and 26, S 32, and Ni 58 and 60. Two boundary layer counter telescopes with improved energy resolution and particle selectivity were used. Investigation of transfer reactions with deuterons included pickup reactions on light nuclei, the (d,α) reactions of Mg and Si isotopes, and angular distribution of the Cr 53 (d,t) reaction to determine the ground state wave function of Cr 53 and the levels in Cr 52. The emphasis in the cyclotron work was on experimental studies of two-step reactions of the type a+A→B*+b, B*→C+c, and results of two-particle correlations in nuclear reactions are given in detail. Construction of a new scattering chamber and addition of a rotating mount to an existing 50-cm chamber are mentioned. Transl. by K.W.

N67-32346# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).

ANNUAL REPORT OF THE MAX-PLANCK-INSTITUT VISITORS AT THE KARLSRUHE NUCLEAR RESEARCH CENTER [JAHRESBERICHT DER GASTGRUPPEN DES M.P.I. IM KERNFORSCHUNGSZENTRUM KARLSRUHE]

In its [Nucl. Phys. Work] 1966 p 182–190 refs (See N67-32341 18-24)

Capacity and beam energy of the facility's isochron-cyclotron are described, followed by summaries of experiments that cover: (1) inelastic scattering of 52 MeV deuterons, and elastic scattering on the target nuclei carbon through uranium; (2) pickup of protons on medium-weight nuclei; and (3) development of measuring apparatus, including a boundary layer counting telescope for He 3 and alpha particles, a telescope for 52 MeV protons, a 1-liter gas target, and use of a Ge(Li) detector for spectroscopy of 52 MeV deuterons and their reaction products. Transl. by K.W.

N67-32347# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
ANNUAL REPORT OF THE MAX-PLANCK-INSTITUT VISITORS AT CERN [JAHRESBERICHT DER GASTGRUPPEN DES M.P.I. IM CERN]
In its [Nucl. Phys. Work] 1966 p 191–211 refs (See N67-32341 18-24)

Progress and results of the following four studies in nuclear chemistry are summarized: irradiation and nuclear reaction of antiprotons in C 12 and Ar 27; mica-uranium sandwich experiments in nuclear reaction at high proton energies; search for nuclear triplet fission with argon-induced reactions on heavy elements; and fission experiments at 18 GeV using solid state detectors. Two reports summarize studies with mesons, one of which lists results of an experiment concerning interference of the decays $K_L \rightarrow \pi^+\pi^-$ and $K_S \rightarrow \pi^+\pi^-$, while the other is concerned with measurements of π and μ meson X-rays. Summarized in a separate article is an experiment to determine the neutretto rest mass; experimental arrangements, the target, the spark chamber, and the spectrometer are described. Transl. by K.W.

N67-32469# Eidgenossische Technische Hochschule, Zurich (Switzerland).
INVESTIGATION OF SPONTANEOUS FLUCTUATIONS IN THE APPLICATION OF SEMICONDUCTOR DIODES AS DETECTORS OF NUCLEAR RADIATION
Larry Scott (Ph.D. Thesis) 1966 104 p refs
(DISS-3845) CFSTI: HC $3.00/MF $0.65

Spontaneous fluctuations in the application of semiconductor diodes as detectors of nuclear radiation was studied and results are summarized as follows: (1) Experimental confirmation of the noise theory of B. Schneider and M.J.O. Strutt for recombination-generation currents was obtained. (2) Nuclear radiation was used as an instrument to investigate the electrical properties of semiconductor diodes with results that further confirm the Schneider-Strutt theory. (3) The assumed Poisson distribution of the emission rate of α-particles was confirmed by means of a noise measurement rather than a counting experiment. (4) A new statistical theory for multiplicative processes was derived and evidence shown to support its validity. (5) An inexpensive detector system is suggested that would measure the intensity of the nuclear radiation by means of the fluctuations in the induced detector current. (6) A theoretical relationship between shot and resistance noise is developed and applied to ideal diodes it yields results that are in agreement with previous theories. (7) Detailed knowledge of the noise present at the output of a detector of nuclear radiation is important in the application of such devices. A noise figure is defined for a detector circuit. S.C.W.

N67-32643# Hughes Research Labs., Malibu, Calif.
ELECTRON REFLECTION COEFFICIENT AT ZERO ENERGY I: EXPERIMENTS
H. Heil and J. V. Hollweg Mar. 1967 26 p refs
(Contract AF 19(628)-4297)
(AFCRL-67-0228; AD-652223) CFSTI: HC $3.00/MF $0.65

The zero energy reflection coefficient of electrons at a freshly evaporated silver surface has been measured to be 7% + or 1%. The coefficient rises linearly with 39% e/V over more than 0.5 eV. Particular care is taken that only those electrons which have actually interacted with the surface are counted; those which have been reflected by the applied field without interaction with the surface are not counted. This is accomplished by (1) use of a total energy spectrometer and (2) simultaneous recording of the energy spectrum and target current. Therefore, the reflection coefficient determined is essentially that for orthogonal incidence. This report is intended as a critical discussion of the experimental method; the measured coefficient is thought to be caused by reflection in the patches, and agrees with the value to be reported in a subsequent paper. Author (TAB)

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-31516* Nevada Univ., Reno. Desert Research Inst.
MAGNETO-GRAVITY WAVES
F. Winterberg and Alden Mc Lellan, IV [1965] 75 p refs
(Grant NGR-29-001-016)
(NASA-CR-86604) CSCL 20I

Small amplitude low frequency waves are treated in a plasma of infinite conductivity in the presence of magnetic and gravitational fields. In general, there are three kinds of wave motion; namely, acoustic, gravity, and hydromagnetic. In this analysis, three wave modes were found which we called the +mode, −mode, and the Alfven mode. Each mode is strongly coupled to each of the three kinds of motions, with the exception of the Alfven mode, which is independent of compressibility and gravity, since it can be separated from the dispersion relation. The local dispersion relation is derived and expressed in a nondimensional form independent of the constants describing a particular atmosphere. It is shown to exhibit the behavior of stable and unstable modes of wave propagation, which are displayed on a number of graphs and in tabular form. The variation of the density with height is taken into account by a generalized W.K.B. method. Equations are found which give the height at which wave reflection occurs. This determines the maximum heights up to which the three modes can propagate. Author

N67-31654*# Avco-Everett Research Lab., Everett, Mass.
[STUDY OF PLASMA RADIATION SHIELDING] Quarterly Progress Report, 24 Mar.–23 Jun. 1967
Jul. 1967 35 p
(Contract NAS8-20310)
(NASA-CR-86614) CFSTI: HC $3.00/MF $0.65 CSCL 18F

For a NASA contract, progress is reported in several directions: spacecraft integration, solenoidal experimentation, and the diocotron theory. Infrared voltages in excess of 200 kv were achieved by using total charge measurements. It was found that the total charge in the torus can be accurately measured by using the current buttons to measure the frequency of the fundamental diocotron oscillation (small amplitude). The behavior of a diocotron wave during cloud compression was studied. A detailed study was conducted of the limits occurring during charge injection. From these studies it is believed that the current now injected is about as large as possible within the geometrical constraints of the apparatus. Initial experimental and theoretical work has also been started on the design of an experiment to check the feasibility of new shapes for a plasma radiation shield. R.U.

N67-31656*# Volt Technical Corp., Washington, D. C.
ON THE PASSAGE OF LOW FREQUENCY ELECTROMAGNETIC WAVES THROUGH THE IONOSPHERIC PLASMA [O PROKHOZHDENII ELEKTROMAGNITNYKH VOLN SVERKHNIZKOY CHASTOTY CHEREZ IONOSFERNUYU PLASMU]
V. I. Aksenov 3 Jul. 1967 10 p refs Transl. into ENGLISH from Radiotekhn. i Elektron. SSSR, v. 11, no. 6, 1966 p 1030–1036 Presented to the All-Union Conf. on Cosmic Space Phys., Jan. 1965
(Contract NAS5-12487)
(NASA-CR-86634; ST-RWP-AI-10 633) CSCL 20I

A rigorous solution is obtained of the problem of low frequency electromagnetic wave passage through a plane-stratified magnetoactive ionospheric plasma in case of longitudinal propagation (the angle α between the wave vector k and the direction of the external magnetic field being zero). The transmission and reflection factors are found on the basis of the above solution in the

frequency band 1.5–100 kc/sec for the daytime and nighttime ionosphere models. It is shown that in the case under consideration the geometrical optics approximation does not coincide with the rigorous solution of the wave equation in frequencies <10 kc/sec, whereupon this discrepancy increases with frequency decrease. Author

N67-31681# Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
CONVERGING DETONATIONS
Robert L. Conger *In its* Foundational Res. Proj. 15 Mar. 1967 p 5–18 refs (See N67-31679 18-26)

A mathematical model is presented for the flow of detonation products behind a converging detonation front. The independent variables are reduced to one space coordinate and time with the space coordinate expressed in general curvilinear coordinates so that the results can be applied to any geometry. Based on flash X-ray data and the mechanical shock conditions across the detonation front, an equation of state is derived which applies to the high density region behind the detonation head. The model is applied to spherical and spheroidal coordinate systems. Author

N67-31682# Naval Ordnance Lab., Corona, Calif. Electricity and Magnetism Div.
CORRECTIONS TO THE SAHA EQUATION
Charles A. Roberts *In its* Foundational Res. Proj. 15 Mar. 1967 p 19–35 refs (See N67-31679 18-26)

The Saha equation is used for the calculation of electron, ion, and molecular fraction densities in a gas at thermodynamic equilibrium. The equation considers that there are no interactions between the particles in the gas. Calculations have been made here to investigate the effect of the electrostatic interaction of the ions and electrons. It is shown that the interaction term derived is dependent on both the fraction ionization and the density of particles relative to standard conditions. Applications of the correction to the Saha equation may be useful in the field of shock waves and for moderate density systems. Author

N67-31687 Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
ANALYSIS OF POPULATION OF EXCITED STATES OF IONS AND ITS APPLICATION TO ELECTRON TEMPERATURE AND DENSITY MEASUREMENTS
Szymon Suckewer 1967 37 p refs
(INR-782/XVIII/PP)

The step-wise excitations of ions are discussed and densities N_e of electrons at which the solar corona model is applicable to plasma are estimated. For this case the population of $2\,^1d_2$ and $3\,^3P_2^*$ states of C_{III} ion was calculated. Expressions for the ions densities at selected excited states, at which corona relations are not applicable, were obtained taking into account collisional de-excitations transitions. Dependence of density of C_{III} ions in states $2\,^1D_2$ and $3\,^3P_2^*$ on N_e and kT_e was determined for this particular case. Author

N67-31721* Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
ANALYSIS OF A ROTATING PLASMA EXPERIMENT
Peter M. Sockol 1967 31 p refs
(Grant NGR-22-009-052)
(NASA-CR-86855) CSCL 20I

In experiments with a homopolar device it has been observed that for low values of the discharge current the voltage drop across the plasma is proportional to the magnetic field and independent of the current and pressure. The rotational velocity corresponds to a kinetic energy for the ions equal to the ionization potential of the gas. These experiments have been analyzed using a steady-state continuum model of the flow in which the bulk of the gas rotates at a uniform velocity and the current is confined to thin Hartmann boundary layers on the end-walls. The voltage drop has been calculated as a function of current, pressure, magnetic field, and atomic species. The dependence on these parameters is in good agreement with the measurements under all conditions, while the magnitude of the voltage is generally smaller than the observed value by a factor of two. Author

N67-31806* Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
COMMENTS ON "LIMITING VELOCITY FOR A ROTATING PLASMA"
J. A. Fay and P. Sockol [1967] 7 p refs
(Grant NGR-22-009-052)
(NASA-CR-85975) CSCL 20I

Consideration is given to the rotating plasma experiments reviewed in literature. Application is to the experiment for sufficiently high initial pressure (greater than about 50 Hg). General agreement between the present theory and the previous one is fair, but for low currents the theory predicts that the azimuthal velocity is only slightly more than half the ionization speed. R.U.

N67-31813*# Michigan Univ., Ann Arbor. High Altitude Engineering Lab.
THE SCATTERING OF ELECTROMAGNETIC WAVES FROM A PLASMA-IMMERSED CYLINDER Scientific Report
Edmund K. Miller Dec. 1966 27 p refs
(Contract NASr-54(05))
(NASA-CR-86631; Rept.-05627-6-S) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The scattering cross-section of a perfectly conducting cylinder in a compressible plasma for incident transverse electric (TE) and transverse magnetic (TM) waves is theoretically investigated and numerical results are presented. The sheath which forms about an object in a plasma is represented in two ways, the first replacing the actual sheath by a free-space layer (the vacuum sheath) and the second taking into account the actual sheath inhomogeneity (the inhomogeneous sheath). It is found that only for near grazing incidance; for the electron plasma frequency near the incident wave frequency; or in the limit of small cylinder radii, are the TE–TE and TM–TM cross-sections appreciably affected by the plasma compressibility and sheath. Author

N67-31848*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF AZIMUTHAL INHOMOGENEITY OF PLASMA IN A HOMOPOLAR [ISSLEDOVANIYE AZIMUTAL'NOY NEODNORODNOSTI PLAZMY V GOMOPOLYARNIKE]
E. M. Drobyshevskiy, S. I. Rozov, and A. M. Studenkov Jul. 1967 7 p refs Transl. into ENGLISH from Zh. Tekh. Fiz. (Leningrad), v. 37, no. 5, 1967 p 979–983
(NASA-TT-F-11110) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The inhomogeneity of a plasma in azimuthal direction was investigated in a homopolar machine placed in a solenoid, using probes, photomultipliers, and oscillographs for determining the cause of blocking of the free flow of azimuthal current. The formation of current canals was found responsible for the generation of forces and discharges, resulting in a Hall electric field which decreases in azimuthal direction and produced breakdown and formation of new cathode spots. It is concluded that the velocity of the plasma canal is limited mainly by the rate of displacement of the cathode spot at the electrode. Author

N67-32114*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
MHD BOUNDARY LAYERS INVOLVING NON-EQUILIBRIUM IONIZATION Quarterly Report, 25 Jan.–24 Apr. 1967
Arthur Sherman, Eli Reshotko, Giles Crimi, and Frank Cristiano 24 Apr. 1967 41 p
(Contract NASw-1586)
(NASA-CR-86605; QR-1) CSCL 20I

The problem being considered is the boundary layer that will develop over the segmented electrode wall in an MHD channel when a nonequilibrium plasma is flowing. The characteristics of the plasma sheath at the base of the continuum boundary layer as well as the variation of the electron temperature throughout the boundary layer are considered. Due to our aims to study finite electrode segments in the wall over which the boundary layer develops, a finite difference technique is used in solving the boundary layer equations. This permitted the study of nonsimilar behavior in a reasonably accurate way. Author

N67-32127# Columbia Univ., New York. Electronics Research Labs.
ENERGY TRANSFER AND ELECTRON CONDUCTION IN THE FLUID TRANSPIRATION ARC
P. S. Tschang 17 Feb. 1967 219 p refs
(Contract AF 49(638)-1395)
(T-1/312; AFOSR-67-0769; AD-653196) CFSTI: HC $3.00/MF $0.65

The energy relaxation and electrical conductivity of an electron gas in an argon arc discharge at 1 atm has been examined theoretically and observed quantitatively in an experimental arrangement. The plasma column utilized for study is the type generated in a fluid transpiration arc equipment in which the argon working fluid is injected through a porous graphite anode. The rate of forced convection is such as to insure significant electron-heavy particle nonequiligrium in the sample volume of interest. Accordingly, the electrical conductivity and the two-temperature volume rates of energy transfer have been obtained. The diagnostic techniques include Hall-effect magnetic field probe for current density, floating electrostatic probe for electrical field, spherical thermocouple heat transfer probe for heavy particle temperature and continuum spectrum intensity measurement for electron density and temperature. High-speed motion pictures provide a qualitative study of the plasma volume as well as its reaction to a material probe. Author (TAB)

N67-32132* Volt Technical Corp., Washington, D. C.
ON NONLINEAR DRIFT WAVES IN A PLASMA
V. I. Petviashvili 19 Jun. 1967 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR, Fizika (Moscow), v. 174, no. 1, 1967 p 66–68
(Contract NAS5-12487)
(NASA-CR-86678; ST-PP-10624) CSCL 20I

This paper establishes that because of the possibility of drift wave propagation in the plasma in the presence of an inhomogeneity across the magnetic field, as the time goes on, the inclination of these waves' leading front becomes steeper and steeper by comparison with the initial state, so long as the mean wave frequency does not become so high that it becomes indispensable to take into account the inertia of ions across the magnetic field. Then the wave assumes a stationary state provided the amplitude is not too great. This may lead to strong plasma turbulization in the presence of instability relative to low-frequency drift waves, inasmuch as the correlation between oscillations in any two points of the plasma weakens considerably as the amplitude of oscillations rises. Author

N67-32154# Royal Inst. of Tech., Stockholm (Sweden). Dept. of Microwave.
THE INFLUENCE OF ENERGY-DEPENDENT RELAXATION TIMES AND CHARGECARRIER MASS ON IONIZATION WAVES IN PLASMAS
Bengt Anderson 1 Feb. 1967 38 p refs
(Contract AF 61(052)-895)
(RADC-TR-67-322; SR-16; AD-652839) CFSTI: HC $3.00/MF $0.65

The earlier theory for ionization waves in plasmas, where the dielectric relaxation time is very short, is developed to include energydependent relaxation times and mass of the charge carriers. The energydependence in many cases has a considerable influence and may also change the nature of the instabilities earlier predicted. An application to InSb is made. In the last section also the influence of a finite dielectric relaxation time is considered. Within the approximation used the influence is small except for giving rise to another mode corresponding to decay of free charge. An application to intervalley scattering in the double valley conduction band of semiconductors is made and a condition for a negative resistance instability is given. Author (TAB)

N67-32260# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
AN INVESTIGATION NEAR THE CATHODE OF THE POISEUILLE ARC
J. F. Bott Feb. 1967 20 p refs
(Grant NSF GK-65)
(TR-28)

The Poiseuille arc inlet development region where the cold gas flows by the cathode and becomes heated by the electric current was studied to determine (1) side wall heat transfer as a function of distance from the cathode, and (2) the temperatures in the developing region inferred from the continuous radiation measured at various distances from the cathode. Data presented give a qualitative picture of how the gas is heated in the developing region. The plasma is confined to a very high temperature core just in front of the cathode with a peak temperature of about 0.09 inches in front of the cathode. The gradient of the electric field is predicted to increase approaching the cathode so that it may be fairly large within 0.1 inch of the cathode. Because of the confinement of the plasma, its temperature and therefore electrical conductivity must be high in the center to support a current of 100 amps. Although no symmetric data were obtained in the hot core region at the higher flow rate, the magnitude of the intensities indicated that the temperatures were affected by flow rate only very slightly. Higher flow rates increased the length of the developing region. The heat transfer data reached a maximum of 550 watts/cm at only 0.37 inches from the cathode tip for a flow rate of 0.05g/sec and decreased slightly to 535 watts/cm farther downstream. The influence of the radiation from the very hot core produced considerable heat transfer to the walls even upstream of the cathode. S.C.W.

N67-32502# Stanford Univ., Calif. Stanford Electronics Labs.
PLASMA PHYSICS AND QUANTUM ELECTRONICS
In its Quart. Status Rept., 1 Oct.–31 Dec. 1966 31 Dec. 1966 p 1–5 (See N67-32501 18-10)

A modification of the programming of simple, two-dimensional plasma problems is reported. The modification moves the boundaries to infinity, and the program is considered capable of coping with plasma problems near a space vehicle. Continuing work in the investigations of a microwave motor for converting microwave radiation directly to mechanical motion of solids or fluids is also reported. A previously derived dispersion relation for a uniform plane wave propagating in an infinite lossy fluid was extended. It was found that two different waves could be excited, and the excitation and propagation directions were determined. N.E.N.

N67-32538# Republic Aviation Corp., Farmingdale, N. Y.
PULSED PLASMA STUDIES Final Status Report, May 1959–Jun. 1966
John J. McIver 15 Feb. 1967 16 p refs
(Contract Nonr-2851(00))
(FHR-3449; PCD-TR-67-4; AD-652408) CFSTI: HC $3.00/MF $0.65

This report covers the chronological series of events leading up to the integration of a pulsed plasma electric thruster system into a Naval Research Laboratory satellite, payload 140. The period covered is from April 1964 to June 1966, and the report describes

the progress and problems associated with the system integration and in addition describes the case history of the attempts to obtain Air Force support in obtaining a launch vehicle for the payload. The last portion of the report covers the bibliography of all publications generated directly or partially under this contract since 1959. Author (TAB)

N67-32596*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ARC RESEARCH, SECTION III
Stanley M. Neuder *In its* Radiometry Progr., 1st Trimester, 1967 Apr. 1967 3 p (See N67-32594 18-23)

Several spectroscopic methods of measuring ion and electron temperatures of an optically thin plasma in local thermal equilibrium were considered, and one of the more promising methods permits the determination of plasma temperature distributions for 1 to 2 kw short arc. Spectral distribution of a zirconium lamp in the 0.3 to 2.4 micron range is found to be mostly in the infrared. It was found that plasma potential is a function on inter-electrode spacing and increases with increased gap width; and that inert gases of higher atomic masses sustain higher electrical potentials for a specific current. M.W.R.

N67-32597*# Electro-Mechanical Research, Inc., Sarasota, Fla.
ELECTROMAGNETIC MEASUREMENTS Quarterly Progress Report, 1 Dec. 1966–28 Feb. 1967
Roy McIntosh, Roberta Urschel, Daryl Mosier, Ralph Stair, and Sam Hall *In* NASA. Goddard Space Flight Center Radiometry Progr., 1st Trimester, 1967 Apr. 1967 31 p (See N67-32594 18-23)
(Contract NAS5-9244)

A spectral irradiance measurement was made on a vortex stabilized arc (V-22) of helium 80 psig, at 4 kw, with open loop; and a computer printout is included for V-21 argon, 70 psig, at 3.6 kw, very high flow. Mention is made of standard lamps and an 80 kw arc lamp, and of plumbing modifications for the votex arc. Solar simulation of thermal coatings were made with the A1200 solar simulator, and fabrication of the in vacuum uniformity scanner for this simulator is reported. Spectral irradiance measurements with the X-25L solar simulator were made, and computer printouts of these results are presented. Effective absorptances of many paints and coatings were also computed. M.W.R.

N67-32827# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ELECTRON RECOMBINATION IN A PLASMA EXPANDING IN A VACUUM
N. M. Kuznetsov and Yu. P. Raizer *In its* J. of Appl. Mech. and Tech. Phys., 5 Dec. 1966 p 1–18 refs (See N67-32626 18-34)

The question of residual ionization as the plasma disperses in a vacuum is reexamined for the case of a heated single-atom ionized gas expanding in a vacuum in spherical symmetry. Consideration is given to the subsequent inertial stage of dispersion, in which its intrinsic energy has already been transformed to kinetic energy, the dispersion is practically stable, and the gas density declines in the course of time as $1/t^3$. Changes are examined in the degree of ionization with time at low temperatures after disruption of ionization equilibrium and termination of the ionization process. It is assumed that the gas contains only single-charge ions. Equations of recombination kinetics and energy are derived; and the rate of deactivation of an excited atom by collisions is determined. The computations presented were made on the supposition that energy transmitted during radiational emissions in excited atoms is primarily converted to radiation, completely disappears from the gas cloud, and consequently is lost to the gas. M.G.J.

N67-32681# Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics.
MECHANISMS AND DYNAMICS OF COAXIAL PLASMA ACCELERATION Final Report
Winston H. Bostick Mar. 1967 9 p refs
(Grant AF-AFOSR-465-65)
(SIT-P199; AFOSR-67-1062; AD-652222) CFSTI: HC $3.00/MF $0.65

The primary objective of our research is the exploration of the character of the current sheet which separates a plasma from a magnetic field. We have shown that plasma vortices of two different types are produced in pairs at this interface. One type of vortex has its filamentary axis parallel to the background magnetic field and the other type has its filamentary axis perpendicular to the background magnetic field. Both types have now been observed and studied in the plasma coaxial accelerator. The parallel to the background magnetic field vortices have been observed and studied in plasma flow over a magnetic dipole and in the firing of a small two-wire button gun across a magnetic field. Without a doubt both of these types of vortices are the components out of which plasma turbulence is made. Author (TAB)

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-31516*# Avco-Everett Research Lab., Everett, Mass.
ADVANCED SUPERCONDUCTING MAGNETS INVESTIGATION Quarterly Progress Report, 10 Feb.–10 May 1967
10 May 1967 35 p refs
(Contract NAS8-21037)
(NASA-CR-86615; QPR-2) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Analytical work has been concentrated on the problem of modeling the effects of the non-linear heat transfer characteristics of liquid helium on composite conductor stability. A first approximation to the effective boiling curve is described and a zero-dimensional analysis is presented which yields a method for determining a stability map for a given superconducter and cooling configuration. Preliminary results of an extension to the one-dimensional theory which appeared in the last progress report are given. The initial steps toward a solution of a two-dimensional problem with anisotropic thermal conductivity and non-linear heat transfer coefficient are discussed. In addition, experiments have been carried out on test samples of composite conductor with a localized heat source. Construction was such as to allow thermal gradients primarily with length. This configuration resembled the model utilized in the one-dimensional theory and provided data which correlates qualitatively with the behavior predicted by that theory. Typical experimental results are included, but data reduction is not yet complete. Author

N67-31637# Idaho Nuclear Corp., Idaho Falls. National Reactor Testing Station.
MATRIX: A FORCE CONSTANT ADJUSTER PROGRAM TO OBTAIN LEAST SQUARES FIT TO OBSERVED FREQUENCIES OF MOLECULES AND CRYSTALS
J. K. Boyter and H. L. McMurry Apr. 1967 12 p ref
(Contract AT(10-1)-1230)
(IN-1077) CFSTI: HC $3.00/MF $0.65

A Fortran program for the IBM 7040 is described, which is a force constant adjuster to obtain a least squares fit to

observed frequencies of molecules and crystals. The input data are explained and an illustrative application to diamond is presented. Author (NSA)

N67-31679# Naval Ordnance Lab., Corona, Calif.
FOUNDATIONAL RESEARCH PROJECTS Quarterly Report, Oct.–Dec. 1966
15 Mar. 1967 108 p refs
(NOLC-705; AD-651544) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. MAGNETO-OPTICAL OBSERVATIONS WITH PULSED ARGON LASER LIGHT J. L. Tomlinson p 1–3 refs (See N67-31680 18-16)
2. CONVERGING DETONATIONS R. L. Conger p 5–18 refs (See N67-31681 18-25)
3. CORRECTIONS TO THE SAHA EQUATION C. A. Roberts p 19–35 refs (See N67-31682 18-25)
4. TWO-PHONON MATRIX ELEMENTS AND ABSORPTION FOR CRYSTAL MODELS WITH ZINC BLENDE STRUCTURE A. Nedoluha p 37–47 refs (See N67-31683 18-26)
5. OPTICAL CONSTANTS OF GERMANIUM IN THE SPECTRAL REGION FROM 2.40 TO 3.85 eV R. F. Potter p 48–60 refs (See N67-31684 18-26)
6. TRANSMITTANCE AND REFLECTANCE OF INFRARED OPTICAL MATERIALS FROM 2. TO 50 MICRONS D. E. McCarthy p 61–65 refs (See N67-31685 18-26)
7. OPTICAL SPECTRUM OF EuF_3 H. H. Caspers, H. E. Rast, and H. R. Marlin p 67–101 refs (See N67-31686 18-26)

N67-31683# Naval Ordnance Lab., Corona, Calif. Infrared Div.
TWO-PHONON MATRIX ELEMENTS AND ABSORPTION FOR CRYSTAL MODELS WITH ZINC BLENDE STRUCTURE. PART II: NEAREST NEIGHBOR INTERACTION THROUGH NONCENTRAL HARMONIC AND CENTRAL THIRD ORDER POTENTIALS
Alfred Nedoluha *In its* Foundational Res. Proj. 15 Mar. 1967 p 37–47 refs (See N67-31679 18-26)

The effect of the transition matrix elements on two-phonon absorption in semiconducting crystals with zinc blende structure is investigated. The summation bands in a crystal of rigid particles with nearest neighbor interaction through central second and third order potentials were calculated. A generalization of the crystal model to harmonic noncentral forces and a calculation of the matrix elements of absorption for this model in two symmetry directions are presented. Author

N67-31684# Naval Ordnance Lab., Corona, Calif. Infrared Div.
OPTICAL CONSTANTS OF GERMANIUM IN THE SPECTRAL REGION FROM 2.40 TO 3.85 eV
Roy F. Potter *In its* Foundational Res. Proj. 15 Mar. 1967 p 48–60 refs (See N67-31679 18-26)

The room temperature optical constants ϵ_1, ϵ_2, n, and k for an electropolished germanium sample have been measured in the spectral region 2.4–3.85 eV, using the pseudo-Brewster angle technique. The quantities $X_n^2 = \sin^2 \phi_B \tan^2 \phi_B$ and R_n, the ratio of the parallel reflectance to the perpendicular reflectance, are determined at the pseudo-Brewster angle ϕ_B, which can be used to determine the constants. A quartet of weak features in ϵ_1, accompanied by thresholds in ϵ_2, are evident between 2.6 and 3.1 eV. These are attributed to M_0 type electronic transitions between Γ'_{15} and Γ'_{25} bands at the center of the Brillouin zone, with spin orbit splittings of 0.12 and 0.29 eV, respectively. A set of three features exhibiting peaks in ϵ_2 accompanied by negative slopes for the corresponding values in ϵ_1 are observed at 3.30, 3.40, and 3.84 eV. These are attributed to M_1 transitions occurring at one or more general points in the Brillouin zone. These results and assignments are compared with other reflectance and electroreflectance data in the literature and with several theoretical treatments of the electronic band structure for germanium. Author

N67-31685# Naval Ordnance Lab., Corona, Calif. Infrared Div.
TRANSMITTANCE AND REFLECTANCE OF INFRARED OPTICAL MATERIALS FROM 2 TO 50 MICRONS
Donald E. McCarthy *In its* Foundational Res. Proj. 15 Mar. 1967 p 61–65 refs (See N67-31679 18-26)

Transmittance and reflectance measurements at 2 to 50 microns in the infrared region are given for rubidium chloride, rubidium bromide, rubidium iodide, strontium titanate, indium phosphide, and tellurium. Author

N67-31686# Naval Ordnance Lab., Corona, Calif. Infrared Div.
OPTICAL SPECTRUM OF EuF_3
Hubert H. Caspers, Howard E. Rast, and H. Ronald Marlin *In its* Foundational Res. Proj. 15 Mar. 1967 p 67–101 refs (See N67-31679 18-26)

The absorption spectrum of EuF_3 powder has been obtained in the region from 1.8–10μm. By means of a diffuse reflection technique, the crystal sublevels of the $^5D_{0,1,2}$ states were obtained at liquid nitrogen temperature. Fluorescence from the $^5D_0$ state and from some of the crystal sublevels of the $^5D_{1,2}$ states to the ^7F_J (J=0, 1, 2, 3, 4, 5, 6) states has been observed. From an analysis of the observed transitions, it was possible to assign 2J+1 Stark components to the observed states, in agreement with the C_s site symmetry for Eu^{3+} in EuF_3. The observed crystal splittings and the experimentally determined barycenters compare favorably with the observed Stark components of Eu^{3+} in other host lattices. Author

N67-31793# Linde Co., Indianapolis, Ind. Speedway Labs.
SINGLE CRYSTAL PEROVSKITES AS ELECTROOPTICALLY ACTIVE MATERIALS Quarterly Progress Report, 1 Oct. 1966–1 Jan. 1967
Homer Fay 1 Jan. 1967 93 p refs
(Contract AF 33(615)-5410)
(QPR-2; AD-650411) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. KTN GROWTH p 4–5
2. COMPLEX PEROVSKITE COMPOUNDS p 5–7
3. ELECTROOPTIC TESTS p 8–11
4. PLANS FOR NEXT QUARTER p 12–13 refs
5. CHARACTERIZATION OF POTASSIUM TANTALATE-NIOBATE CRYSTALS BY ELECTROOPTIC MEASUREMENTS H. Fay 9 p refs (See N67-31794 18-26)

N67-31794# Linde Co., Indianapolis, Ind. Speedway Labs.
CHARACTERIZATION OF POTASSIUM TANTALATE-NIOBATE CRYSTALS BY ELECTROOPTIC MEASUREMENTS
Homer Fay *In its* Single Crystal Perovskites as Electroopt. Active Mater. 1 Jan. 1967 9 p refs Presented at the Intern. Conf. on the Characterization of Mater., State College, Pa., 16–18 Nov. 1966 (See N67-31793 18-26)
(Contract AF 33(615)-5410)

The electrical and optical properties of crystals of potassium tantalate–niobate (KTN) are compared with the properties expected for the ideal perovskite structure. Melt-pulled crystals obey the Curie–Weiss law but exhibit dielectric and optical anisotropy. The striations that are observed perpendicular to the growth direction are found to consist of both permanent lines and bands and regions of variable phase retardation. Local variations in the electrooptic effect indicate that the latter are caused by local changes in the dielectric impermittivity. A variation in Ta/Nb of as little as 0.6 mole % could have produced these abberations. The quadratic electrooptic effect in KTN is found to be isotropic. Author

N67-31812*# Delaware Univ., Newark. Dept. of Physics.
PRODUCTION AND ANNEALING OF INTRINSIC DEFECTS IN X-RAY IRRADIATED CADMIUM SULFIDE
Joseph Charles O'Connell (Ph.D. Thesis) Jun. 1967 76 p refs
(Grant NsG-573)
(NASA-CR-86629; TR-14) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Pure CdS single crystal platelets were exposed to X-rays of up to 300 keV at room temperature and liquid nitrogen temperature. Spectral distribution of photo current and thermally stimulated current measurements were made in ultrahigh vacuum ($\approx 10^{-10}$ torr) before and after irradiation and after annealing above room temperature. A model is proposed to explain the observed changes in these measurements based on displacement in the sulfur sublattice. An electron trapping level at $E_c - E_t = 0.5$ eV is identified as due to sulfur vacancies. In addition a recombination center is produced by sulfur vacancies diffusing to other defects to form associates. The damage produced anneals to a large extent after a heat treatment at 150°C. Further information is obtained from X-ray damage of crystals pre-heat treated in cadmium or sulfur vapor to shift the stoichiometry. Author

N67-31841*# National Aeronautics and Space Administration, Washington, D. C.
ORIGIN OF THE ELASTIC LIMIT OF BODY-CENTERED CUBIC METALS AT LOW TEMPERATURE [SUR L'ORIGINE DE LA LIMITE ELASTIQUE DES METAUX CUBIQUES CENTRES A BASSE TEMPERATURE]
B. Escaig Jul. 1967 35 p refs Transl. into ENGLISH of Paris Univ., Orsay, France, Lab. de Phys. Des Solides Rept.-66/19/HC
(NASA-TT-F-11048) CSCL 20L

The variations in the low-temperature macroscopic elastic limit of body-centered cubic metals is explained on the basis of the formation—under microstrain—of lengths of sessile dissociated screw dislocation. The thermally activated slip and the resultant dislocation multiplication are assumed to occur at the macroscopic elastic limit. It is shown that energies of the order of μ B/100, for the case of iron and tungsten, are necessary to reproduce the totality of measurements made below room temperature; these energies correspond to dissociations of several interatomic distances. Triple dissociations of perfect and stressed dislocations are plotted, and a comparison between theory and experiment is given. Author

N67-31844*# Delaware Univ., Newark. Dept. of Physics.
PRODUCTION AND ANNEALING OF INTRINSIC DEFECTS IN X-RAY IRRADIATED CdS SINGLE CRYSTALS
K. W. Boer and J. C. O'Connell [1966] 13 p refs
(Grant NsG-573)
(NASA-CR-86611; TR-13) CFSTI: HC $3.00/MF $0.65 CSCL 20L

X-rays (300 keV) have been used to produce changes in the defect structure of (1) pure single-crystal platelets of CdS and (2) platelets which have been preheat treated in the vapor of one of its components. The changes were studied by means of the spectral distribution of photocurrent and T.S.C. curves. All measurements were made in ultrahigh vacuum (10^{-10} Torr). The damage produced annealed at temperatures between 100° and 150°C. The reproducible damage-annealing cycle has been explained in terms of intrinsic defects produced in the sulfur sublattice. Damage-annealing cycles for crystals pre-heat treated in Cd or S vapor (stoichiometry shift) provide additional confirmation for the proposed model. Author

N67-32191# Stanford Univ., Calif. Microwave Lab.
GENERATION OF A DOMAIN IN CADMIUM SULFIDE BY INJECTED ACOUSTIC NOISE
William H. Haydl *In its* Microwave Res. Nov. 1966 10 p refs
(See N67-32189 18-10)

Current oscillations in piezoelectric semiconductors have been shown to be due to a traveling high electric field region (a domain), which develops when sufficient amplification of acoustic energy causes negative differential bulk conductivity. The acoustic energy which is amplified may be either a single frequency acoustic signal which is coupled into the crystal by well-known techniques, or it may be the acoustic thermal noise which is of a broad frequency spectrum and which is always present throughout the crystal. Reported is the generation of a domain by injecting acoustic noise of a broad frequency spectrum, centered around the frequency of maximum acoustic gain which is typically in the 3 to 10 GHz range. The thermal acoustic noise is amplified in one sample and coupled into a second sample where it is further amplified and where it generates a domain. The experiment shows that it is the thermal acoustic noise which is amplified and not a shock excited acoustic pulse. S.C.W.

N67-32217*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
ELECTRON AND SOLID STATE PHYSICS
H. Brooks, N. Bloembergen, P. S. Pershan, G. D. Boyd, G. E. Durand et al *In its* Cruft Lab. Mar. 1967 12 p refs (See N67-32215 18-34)
(Contracts ARPA SD-88; Nonr-1866(28))

Second Harmonic Generation (SHG) of light by a Q-switched laser beam from the surface of various metals was investigated. SHG was observed from liquid Hg, single crystal Sb, and single crystal Bi. Phase matching studies of nonlinear electroreflectance in silicon and silver of fundamental and second harmonic reflections, are also reported. Other work is reported on 1) optical properties of liquid crystals, 2) stimulated Raman effects, 3) carbon dioxide laser nonlinear optical investigations, 4) stimulated Brillouin effects, 5) optically induced magnetizations in paramagnetic crystals, 6) optical spectroscopy of divalent rare earths in ionic crystals, 7) semiconducting properties in rare earth doped CdF_2, 8) magneto-optical effects in solids, 9) Raman spectroscopy from mixed and from magnetic crystals, 10) electronic effects in transition metal oxides, and 11) band theory of ferromagnetic anisotropy in nickel. L.S.

N67-32220*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
MICROWAVE APPLICATION OF FERROMAGNETIC AND FERROELECTRIC MATERIALS
R. V. Jones, R. Bartkowski, P. Berger, B. Levine, F. A. Hilton et al *In its* Cruft Lab. Mar. 1967 7 p ref (See N67-32215 18-34)
(Contract AF 19(628)-3874)

Nuclear magnetic resonance measurements of impurities in magnetic garnets; ferromagnetic relaxation in metals and in magnetic oxides; and ultrasonic attenuation in magnetic oxides, are discussed. A table summarizing some preliminary data on permalloy for spin waves at a frequency of 8 Gc, is given. L.S.

N67-32258# Colorado Univ., Boulder. Dept. of Physics and Astrophysics.
ELECTRON SHIELDING IN n-InSb. Technical Report, 1 Jun. 1966–31 May 1967
S. P. Li, W. F. Love, and S. C. Miller Jun. 1967 13 p refs
(Contract Nonr-1147(12))
(TR-3; AD-653107) CFSTI: HC $3.00/MF $0.65

The effect on bound electrons in donor levels by conduction band electrons in n-InSb is investigated using a self-consistent calculation. Results of the calculations show that no bound state exists for impurity concentrations greater than 6 x 10 to the 13th power per cubic centimeter. This shielding appears to be the predominent effect leading to the lack of impurity binding energy. Author (TAB)

N67-32370*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

INFLUENCE OF PARENT AND DAUGHTER DECAY ON TRACER DIFFUSION PROFILES

Donald R. Behrendt Washington, NASA, Aug. 1967 11 p

(NASA-TN-D-4099) CFSTI: HC $3.00/MF $0.65 CSCL 20H

In some radioactive tracer diffusion experiments, the diffusion profile is determined by sectioning the sample and counting the gamma activity of each of the sections. If the daughter decay product is radioactive and has in its decay chain a gamma ray whose energy is close to that of the tracer, a correction to the counting rates of the sections is necessary. Because the daughter decay product is a chemical species different from the tracer, its diffusion coefficient will, in general, be different from the tracer. An equation is developed which gives the diffusion profile for the daughter for a one-dimensional diffusion problem. This solution can be used in making an estimate of the error produced by the daughter decay. With sufficient knowledge of the diffusing species, the correction to the diffusion profile can be made. Author

N67-32395*# Delaware Univ., Newark. Dept. of Physics.

X-RAY AND ELECTRON DAMAGE, AND PHOTOCHEMICAL REACTIONS IN CdS SINGLE CRYSTALS AND LAYERS, AND ANNEALING OF THESE DEFECTS Final Report

K. W. Boer Jul. 1967 5 p refs

(Grant NsG-573)

(NASA-CR-86669) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Marked changes in the spectral distribution of cadmium sulfide photoconductivity and in the thermally stimulated current-curves were found to occur at X-ray irradiation slightly above 250 keV, as long as the CdS crystals are kept in ultrahigh vacuum at room temperature. The X-ray irradiation at 300 keV produces defects, which can be described as sulfur vacancies close to the crystal structure due to focussing collisions. Heat treatment of CdS in sulfur vapor decreases the X-ray damage effect drastically, and is ascribed to a decreased probability to produce sulfur vacancies close to the surface. Extensive investigation in defect structure because of sulfur treatment and vacuum heat treatment were made, and recrystallization of CdS evaporated layers was studied to learn more about the defect structure of CdS. M.W.R.

N67-32484# Royal Inst. of Tech., Stockholm (Sweden). Dept. of Microwave.

THEORY OF DIFFUSION INSTABILITIES IN SEMICONDUCTORS

K. Bloetekjaer 1 Jan. 1967 66 p refs

(Contract AF 61(052)-895)

(RADC-TR-67-321; SR-12; AD-652834) CFSTI: HC $3.00/MF $0.65

A possible mechanism for instabilities in semiconductors is considered. If carrier temperature gradients become large and directed opposite to the density gradients the net diffusion of carriers is reversed, and instabilities may arise. Suitable conditions for the instability are obtained in intrinsic or nearly intrinsic semiconductors at electric field strengths which are sufficiently high to raise the electron temperature to two or three times the lattice temperature. The temperature dependence of the collision frequency has a profound influence on the instability. Suitable materials are those with optical phonon scattering as the dominant collision process, whereas deformation potential scattering suppresses the instability. The maximum frequency for which the instability occurs is of the order of mu-p/(mu-n)(tau-n), where mu-n and mu-p are the electron and hole mobilities and tau-n is the energy relaxation time of electrons. In polar semiconductors this frequency may be well into the microwave region. Author (TAB)

N67-32495# Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.

THE INTERACTION OF CHROMIUM IONS IN RUBY CRYSTALS

Richard C. Powell (Ph.D. Thesis—Ariz. State Univ.) Dec. 1966 130 p refs *Its* Phys. Sci. Res. Paper No. 299

(AFCRL-66-830; AD-651914) CFSTI: HC $3.00/MF $0.65

Absorption, excitation, continuous fluorescence, and pulse fluorescence measurements were made on ruby samples with 0.94% and 2.1% Cr+3 in the temperature range from 4.2K up to 700K. The widths, positions, intensities, and lifetimes of the R and N fluorescence lines were determined at numerous temperatures. The results for the temperature dependence of the linewidths are explained in terms of microscopic strains, Raman scattering of phonons by the impurity ions, and direct phonon processes. The results for the lineshifts with temperature are due to the absorption and emission of virtual phonons. The observed lifetimes of the R and N lines coincide in the temperature range where the systems are thermalized and the observed decays are pure exponentials. At temperatures where the systems are decoupled, an initial rise in fluorescence is observed at the N lines. The subsequent decay has the lifetime of the R lines for a 0.94% sample and the lifetime of the N lines for a 2.1% sample. These results are also explained in terms of energy transfer from single ions to pairs. The effects of reabsorption on the fluorescence spectrum are also discussed. Author (TAB)

N67-32518* Delaware Univ., Newark.

CHANGE OF ELECTRICAL CONDUCTANCE OF CdS SINGLE CRYSTALS DURING HEAT TREATMENTS IN SULFUR VAPOR BETWEEN 500° AND 700°C

William J. Nalesnik (M.S. Thesis) Jun. 1967 82 p refs

(Grant NsG-573)

(NASA-CR-86915) CSCL 20L

The electrical conductance of CdS single crystals was measured, using a four electrode method, as a function of sulfur vapor pressure in the range 0.1 to 800 Torr in a double furnace, which enabled the sulfur pressure and crystal temperature to be regulated independently. In agreement with earlier measurements, the current was observed to decrease with increasing sulfur vapor pressure, obeying a power law of the form $i \approx p_S^{-1/m}$. The exponent 1/m depends upon the crystal temperature and is about 1/24 for 500°<T<520°C, 1/5 for 520°<T<620°, and about 1/15 for 620°<T<700°C. A simple defect model using S vacancies, Cd interstitials, and Cd vacancies is used to explain the observed behavior. Doubly ionized sulfur vacancies are assumed to be predominant in the lowest temperature range, singly ionized Frenkel defects in the intermediate temperature range, and doubly ionized Cd interstitials in the highest temperature range. Author

N67-32548# Paris Univ. (France). Lab. de Physique des Solides.

OPTICAL SPECTROSCOPY OF SEMICONDUCTOR MATERIALS Final Scientific Report, 1 Jan. 1964–31 Dec. 1966

M. Balkanski 31 Dec. 1966 12 p refs

(Contract AF 61(052)-789)

(AFCRL-67-0283; AD-653204) CFSTI: HC $3.00/MF $0.65

A summary is given of accomplishments in the following areas: single phonon absorption bands in fast neutron irradiated silicon; infrared absorption in boron-doped lithium-compensated silicon; optical properties of degenerate silicon. Many aspects of this work are described in greater detail in AD-619 581, AD-621 076, AD-627 066, and AD-632 145. TAB

N67-32672# Pennsylvania Univ., Philadelphia. Dept. of Physics.

LOCAL, NON-LOCAL AND QUANTUM MAGNETOPLASMA EFFECTS IN PbTe

Sidney Perkowitz (Ph.D. Thesis) Apr. 1967 185 p refs

(Contract Nonr-551(51))

(TR-11; AD-652620) CFSTI: HC $3.00/MF $0.65

An experimental and theoretical study of magnetoplasma phenomena in the multi-ellipsoid semiconductor PbTe has been carried out. These phenomena include cyclotron resonance and related effects (i.e., hybrid resonance, tilted-orbit cyclotron resonance, and the dielectric anomaly as low magnetic fields, and propagating-mode effects at higher fields). In the field range 0.3 -7kG, virtually all the predicted local anisotropic effects were seen, including the previously unobserved hybrid resonance. These results are consistent with the (111) ellipsoid model for the Fermi surface of PbTe. Two Azbel-Kaner sub-harmonics were observed, as well as apparent Doppler shifts in the positions of resonances. At magnetic fields between 7 and 17kG, propagating modes manifested themselves in Fabry-Perot patterns. These patterns also exhibited Shubnikov-de Haas oscillations periodically in 1/H, with amplitudes that increased with decreasing temperature. Author (TAB)

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-31872*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A REVIEW OF NACA RESEARCH THROUGH 1957 ON BORON COMPOUNDS AS FUELS FOR JET AIRCRAFT

Paul C. Setze and Henry C. Barnett Washington, NASA, Dec. 1958 51 p refs

(NASA-MEMO-10-7-58E) CSCL 21D (Declassified)

Research included: analytical studies of fuel performance in various type aircraft; experimental investigations conducted in small-scale turbojet and ram-jet combustors, full-scale turbojet primary combustors and afterburners, and full-scale ramjet engines; and flight tests of a 9.75 inch diameter ramjet engine. In most of these investigations, pentaborane was used as fuel, although limited data were obtained with HEF-2 and HiCal-3 fuels. Also included herein is a review of research conducted on boric oxide particle growth and deposition and an analysis of the heat-sink potential of several boron compounds. Author

N67-31967*# Marquardt Corp., Van Nuys, Calif.

FEASIBILITY STUDY OF OXYGEN/HYDROGEN POWDERED METAL IGNITION Final Report, 16 Sep. 1964--15 Sep. 1965

W. B. Lee 1 Sep. 1965 82 p refs

(Contract NAS8-11250)

(NASA-CR-68773; Rept.-25179) CFSTI: HC $3.00/MF $0.65 CSCL 21I

Theoretical and experimental studies were performed on the subject of producing low temperature H_2/O_2 ignitions by the use of catalytic and/or pyrophoric powdered metals. Interest centered on the use of Raney nickel powder, which is both catalytic for H_2/O_2 ignition, and pyrophoric with oxygen. Tests with this material produced a large number of ignitions with cold gaseous hydrogen and liquid oxygen. Ignition times of the order of 10 milliseconde were observed under favorable conditions, and this does not appear to be a limit. The Raney nickel powder was entrained in the hydrogen stream, by passing the latter through a fluidizer assembly just upstream of the injector. It was demonstrated that Raney nickel powder, stored under an atmosphere of hydrogen, should have indefinite shelf life in the activated state, being able to produce ignitions at any time upon contact with oxygen. Author

N67-32645# Picatinny Arsenal, Dover, N. J. Ammunition Engineering Directorate.

EVALUATION OF ASSAY METHODS FOR ELEMENTAL ALUMINUM

Milton Roth Apr. 1967 35 p *Its* Round Robin No. 29

(TR-3558; AD-652269) CFSTI: HC $3.00/MF $0.65

Round Robin No. 29 of the ORKING Group on Analytical Chemistry (ICRPC) was conducted for the purpose of evaluating two assay methods for elemental aluminum and a method for measuring average particle diameter. Interlaboratory agreement was not obtained in any of the test methods, although intralaboratory agreement was good. The reason for this disagreement is unclear, but a need for calibration standards and closer supervision of round robins is indicated. No basis for changing specification methods was established. Author (TAB)

N67-32658# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.

MECHANICAL PROPERTIES OF WIRE REINFORCED GRAINS

R. A. Heller Mar. 1967 77 p refs

(Contract Nonr-266(78))

(TR-38; AD-652359) CFSTI: HC $3.00/MF $0.65

A large variety of experiments have been performed to evaluate the mechanical properties of simulated, wire reinforced solid propellants and to examine typical failure modes of such materials. It has been found that while axial compressive strength, hoop strength, fatigue, and torsion strength increase with aluminum content, axial tensile strength decreases for the tested configurations. Elastic moduli increase with wire content and relations between the various moduli are adequately described by orthotropic relationships. Failure modes are of four types: (1) In axial tension failure takes place by binder separation unless the reinforcing helix is very steep. (2) Hoop tension failure of the wire as a result of stress concentration on the inner surface produces premature failure under internal pressure. (3) In axial compression, longitudinal and diametral bending failure may be attributed to a lack of radial reinforcement. (4) In vibration tests heat generation due to inter-laminar shear and consequent thermal softening of the binder causes failure by delamination. Author (TAB)

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-31844*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ALTITUDE PERFORMANCE OF A FULL-SCALE HIGH-TEMPERATURE TURBOJET ENGINE USING PENTABORANE FUEL AND HEF-2

Joseph N. Sivo and John P. Wanhainen Washington, NASA, Jan. 1959 41 p refs

(NASA-MEMO-12-31-58E) CFSTI: HC $3.00/MF $0.65 CSCL 21E (Declassified)

A full-scale high-temperature turbojet engine was run on both pentaborane and HEF-2 at a simulated altitude of 50,000 feet at a flight Mach number of 0.8. As a result of the high-temperature operation, the boric oxide deposits that occurred were within acceptable limits. The specific fuel consumption was improved 22 percent with pentaborane fuel and 10 percent with HEF-2 as compared with hydrocarbon fuel. Author

N67-31848*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

PRELIMINARY REPORT ON EXPERIMENTAL INVESTIGATION OF ENGINE DYNAMICS AND CONTROLS FOR A 48-INCH RAM-JET ENGINE

George Vasu, Clint E. Hart, and William R. Dunbar. Washington, NASA, 16 Mar. 1956. 65 p. refs.
(NACA-RM-E55J12) CSCL 21A (Declassified)

Engine dynamics and controls data are presented for a ram-jet engine which was operated in a free-jet facility at a Mach number of 2.76 and altitudes from 68,000 to 82,000 ft. The predominant engine dynamic characteristic was dead time, with values ranging from 0.018 to 0.053 sec. The control systems were designed to hold a constant ratio of a diffuser static pressure to an inlet-cone reference static pressure. Response times and percent overshoot to fuel-flow disturbances that would have caused subcritical operation without control are included for a wide range of control settings. For all settings, the control response was fast enough (0.08 to 0.5 sec) to prevent subcritical operation. Author

N67-31622*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PROPULSION ASPECTS OF THE SUPERSONIC TRANSPORT
James F. Dugan, Jr. (NASA, Lewis Res. Center), Arvid L. Keith, Jr., and Emanuel Boxer. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 291–302. (See N67-31606 18-02)

Increases in the operating turbine temperature beyond present-day values will permit substantial reductions in airplane gross weight. Unless significant advances beyond those anticipated are made in turbine cooling technology and in turbine materials, it is unlikely that additional gains will come from still higher turbine temperatures. Because efficiency of engine components is already high, it appears that the needed improvements will have to come from advances in lightweight engine construction and in variable-geometry technology. Although the advanced turbojet engine and the advanced turbofan engine of the studies have shown substantial reductions in airplane gross weight compared with those of present state-of-the-art engines, the use of these engines results in a marginally acceptable supersonic transport. Author

N67-31623*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STUDY OF AN AXISYMMETRIC SUPERSONIC-TRANSPORT INLET
Norman E. Sorensen. *In* NASA, Langley Res. Center. Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 303–313. (See N67-31606 18-02)

In support of the supersonic commercial air transport program, a 20-inch capture diameter axisymmetric mixed-compression inlet model was designed and tested. The main conclusions are that the supersonic portion of the inlet performed as predicted, and the main loss in performance lies in the throat and subsonic diffuser. Since recoveries as high as 97 percent can be attained in the throat, it seems certain that with further development in the throat and subsonic diffuser and with more effort in determining better bleed configurations, an axisymmetric inlet with performance quite adequate for the supersonic transport will be developed. Author

N67-31624*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
REVIEW OF NASA EXHAUST NOZZLE RESEARCH
Jack F. Runckel. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 315–332 refs. (See N67-31606 18-02)

Exhaust nozzles proposed for the supersonic-transport propulsion system are examined in terms of performance, complexity, and special requirements imposed by the supersonic commercial air transport (SCAT) mission. Both nozzle internal performance and thrust-minus-drag performance are considered. Results from investigations of the transonic performance of several representative types of exhaust nozzles applicable to the supersonic commercial air transport are presented. Author

N67-31631*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
OPERATIONAL FACTORS IN RELATION TO SUPERSONIC-TRANSPORT FUEL REQUIREMENTS
Joseph W. Westmore and Joseph W. Stickle. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 425–437 refs. (See N67-31606 18-02)

An analysis of the interaction of operational environment and aircraft characteristics of the supersonic transport in the area of fuel requirements was made. The increment in design range or fuel-carrying capability above that of the basic trip distance is considered in relation to the effects of wind, temperature, anticipated flight-level assignment, and payload load factor. Reserve fuel requirements are discussed and a statistical approach is used in determining en route and holding reserves. It is indicated that protection equivalent to that provided for subsonic jets by current reserve requirements is obtained for the supersonic transport with less than the present Civil Air Regulation en route and holding requirements. Author

N67-31734*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF NOZZLE INLET GEOMETRY ON PERFORMANCE OF A SWIVELED CONVERGENT–DIVERGENT NOZZLE
Albert J. Pavli. Washington, NASA, Nov. 1959. 38 p. ref.
(NASA-TM-X-98) CSCL 21H (Declassified)

The effects of nozzle inlet design variables on the thrust performance and flow characteristics of a swivelable solid propellant type rocket nozzle were investigated to provide missile design information. Also investigated were the effects of various inlet configurations on circulation flow through the swivel gap. None of the inlet configurations investigated had any appreciable effect on thrust performance, whereas several affected the flow coefficient. Author

N67-31843*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF THREE ISENTROPIC ALL-INTERNAL-COMPRESSION AXISYMMETRIC INLETS DESIGNED FOR MACH 2.5
Bernhard H. Anderson and David N. Bowditch. Washington, NASA, Sep. 1960. 29 p. refs.
(NASA-TM-X-259) CFSTI: HC $3.00/MF $0.65 CSCL 21E
(Declassified)

Three all-internal-compression inlets differing only in the length of the supersonic diffuser were experimentally tested in the 10- by 10-foot supersonic wind tunnel at Mach numbers of 2.0 and 2.5 and angles of attack from 0° to 12°. The best bleed system, consisting of a ram scoop on the cowl and flush slot on the centerbody located opposite each other, generally gave the best inlet performance. Author

N67-31918*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND EXPERIMENTAL INVESTIGATION OF A HIGH-WEIGHT-FLOW LOW-PRESSURE RATIO TURBINE
Donald A. Petrash, Robert R. Nunamaker, and Charles A. Wasserbauer. Washington, NASA, Sep. 1959. 32 p. refs.
(NASA-TM-X-6) CFSTI: HC $3.00/MF $0.65 CSCL 21E
(Declassified)

An overall performance evaluation was conducted on a high-weight-flow, low-pressure ratio, single stage turbine. Results indicated that at the equivalent design operating point the rating efficiency was essentially the estimated design value of 0.83, and the equivalent design weight flow was obtained. Author

N67-31975*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF A HIGH SUBSONIC MACH NUMBER TURBINE HAVING A 32-BLADE ROTOR WITH LOW SUCTION-SURFACE DIFFUSION
William J. Nusbaum and Charles A. Wasserbauer Washington, NASA, Oct. 1958 21 p refs
(NASA-MEMO-10-2-58E) CSCL 21E (Declassified)

The overall performance of a single-stage turbine designed for high weight flow per unit frontal area and high specific work output was investigated experimentally to determine the effect of low rotor-blade solidity on losses. A comparison is made herein with the results obtained from two other turbines having the same stator and having rotors designed for the same application but with intermediate and relatively high solidity. All three turbines were designed for low diffusion on the rotor-blade suction surface. The results indicate that the momentum loss per unit blade surface area increased considerably, so that the design-point efficiency was reduced from the optimum value obtained with the intermediate-solidity turbine. Author

N67-32020*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DESIGN AND PERFORMANCE OF AN EXPERIMENTAL ANNULAR TURBOJET COMBUSTOR WITH HIGH-VELOCITY-AIR ADMISSION THROUGH ONE WALL
Carl T. Norgren Washington, NASA, Dec. 1958 53 p refs
(NASA-MEMO-12-28-58E) CSCL 21E (Declassified)

An annular turbojet combustor segment was designed without the conventional combustor-inlet diffuser so that high-velocity air was supplied directly to the combustor. The bulk of this air was admitted through only one wall of the combustor liner. An overall reduction in length of 30 percent was obtained in comparison with a conventional combustor plus diffusers. Combustion efficiencies over 95 percent were obtained with vaporized propane at 15 in. Hg absolute and at combustor-inlet reference Mach numbers of 0.23 and 0.30. Flow patterns determined from a water analog are included. Author

N67-32034* National Aeronautics and Space Administration, Washington, D. C.
APPLICATION OF NON-AFTERBURNING TURBOJETS TO SUPERSONIC FLIGHT
Richard S. Cesaro and Curtis L. Walker 18 Nov. 1955 18 p ref
(NACA-RM-55K16) CSCL 21E (Declassified)

Airplane performance is analyzed to relate the effects of non-afterburning turbojet engine application to all supersonic flight and the resulting ranges of specific engine weight, overall engine efficiency, and airplane variables, i.e. L/D that make this engine application appear feasible. Author

N67-32157*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF THE PARTIAL-ADMISSION PERFORMANCE CHARACTERISTICS OF A SINGLE-STAGE MACH 2 SUPERSONIC TURBINE
Thomas P. Moffitt and Frederick W. Klag, Jr. Washington, NASA, Sep. 1959 15 p refs
(NASA-TM-X-80) CFSTI: HC $3.00/MF $0.65 CSCL 21E (Declassified)

The experimental investigation of the partial-admission performance characteristics of a single stage supersonic turbine is presented. A range of admissions from full admission to 12.5-percent admission was covered. At full admission the equivalent specific work output obtained at design speed and pressure ratio was 33.0 Btu per pound at a static efficiency of 0.425. For all other admissions, no significant effect on performance was noted for either design or off-design conditions of operation. At 12.5-percent admission the prediction method used indicated a drop in expected over-all static efficiency of about 5 percent for the subject turbine. Author

N67-32315# Curtiss-Wright Corp., Wood-Ridge, N. J. Wright Aeronautical Div.
ADVANCEMENT OF SMALL GAS TURBINE ENGINE ACCESSORY TECHNOLOGY Final Report
Harry L. Richardson and Rocco M. Tommasini Apr. 1967 239 p refs
(Contract DA-44-177-AMC-297(T))
(WAD-R-431-F; USAAVLABS-TR-67-13; AD-652896) CFSTI: HC $3.00/MF $0.65

The basic requirements for controls and accessories for gas generators in the 2-to-5 pound per second airflow range are established. These requirements are then investigated in terms of current and projected state-of-the-art relative to the various controls and accessories information supplied by qualified manufacturers. Special attention is given to the application of fluidic control techniques to small gas turbine engines. The report contains conclusions and recommendations relative to obtaining an advanced generation of controls and accessories for small engines. Particular attention is given to improved packaging of the controls and accessories with emphasis on decreasing weight and volume and improvement in maintainability. Engine starting is investigated in detail and it is concluded that a hand charged hydraulic accumulator/hydraulic motor-pump arrangement best meets the requirements of minimum weight, self-sufficiency and austere site operation. Author (TAB)

N67-32348# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE WORKING PROCESS IN THE COMBUSTION CHAMBERS OF GAS-TURBINE ENGINES. (SELECTED ARTICLES)
7 Mar. 1967 83 p refs Transl. into ENGLISH from Aviats. Inst. Tr. (Moscow), no. 157, 1964 p 5–16, 51–58, 59–72, 73–90
(FTD-MT-65-114; TT-67-61676; AD-651088) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. LOCATION OF THE BURNING ZONE IN THE INITIAL PART OF THE FLAME TUBES OF GTE CHAMBERS G. M. Gorbunov, I. A. Lapchinskiy, and V. B. Rutovskiy p 1–17 refs (See N67-32349 18-33)

2. ON THE STRUCTURE OF CIRCULATING MOTION IN A GTE CHAMBER L. A. Kvasnikov p 19–29 refs (See N67-32350 18-33)

3. THE MECHANISM OF BURNING A FUEL–AIR MIXTURE IN A GTE CHAMBER UNDER CONDITIONS OF MAXIMUM LEANING S. I. Shakhurin p 31–49 refs (See N67-32351 18-33)

4. INVESTIGATION OF THE CHARACTERISTICS OF GTE COMBUSTION CHAMBERS IN REGIMES OF MAXIMUM PERMISSIBLE LEANING UNDER HIGH-ALTITUDE CONDITIONS S. I. Shakhurin p 51–72 refs (See N67-32352 18-33)

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-31542*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
HIGH-ENERGY SOLAR X-RAYS OF 7 JULY 1966

T. L. Cline, S. S. Holt, and E. W. Hones, Jr. (Los Alamos Sci. Lab.) Jul. 1967 15 p refs
(NASA-TM-X-55846; X-611-67-348) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The time history and differential intensity of solar X-rays of energies from 80 to more than 500 keV were observed during the flare event of 7 July 1966. These measurements, made from a solar-oriented stable platform on OGO-III, cover the highest differential energy range studied thus far and indicate the greatest intensity in hard X-rays of any solar event observed to date. Three intensity peaks occurred at about 0027, 0029 and 0037 UT, coinciding with the times of microwave and optical intensity maxima. A study of the spectral and temporal characteristics of the X-ray emission, and comparison with the radio and optical data, indicate a non-thermal bremsstrahlung origin for the X-rays. Author

N67-31550* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
LOW ENERGY COSMIC RAY COMPOSITION AND ENERGY SPECTRA MEASURED IN JUNE, 1965
D. V. Reames and C. E. Fichtel Jun. 1967 23 p refs
(NASA-TM-X-55840; X-611-67-270) CSCL 20H

Sounding rockets carrying nuclear emulsions to study the composition and energy spectra of the low energy cosmic rays were flown on June 17 and 23, 1965 from Fort Churchill, Canada. The results show that the intensity of the heavy nuclei ($Z \geq 3$) was about the same as that in July, 1964 and below that measured by other observers in May and early June 1965, before the Forbush decrease on June 15, 1965. The helium nuclei flux between 15 and 22 MeV/nucleon was found to be significantly lower on June 17, 1965 immediately after the Forbush decrease than on June 23, 1965. The charge spectrum indicates that in the region from 40 to 90 MeV/nucleon the ratio of light to medium nuclei fluxes is $0.19 \pm .07$, which is well below the value of 0.5 found at intermediate energies (200 to 400 MeV/nucleon), and that the carbon to oxygen ratio is about 1 rather than 1.6, as found at higher energies. Author

N67-31988*# Volt Technical Corp., Washington, D. C.
ON THE POSSIBILITY OF INVESTIGATION OF PRIMARY COSMIC RADIATION BY TRACKS OF NUCLEAR PARTICLES IN METEORITES AND TEXTILES [O VOZMOZHNOSTI ISSLEDOVANIYA INTENSIVNOSTI PERVICHNOGO KOSMICHESKOGO IZLUCHENIYA PO TREKAM YADERNYKH CHASTITS V METEORITAKH I TEKTITAKH]
L. L. Kasharov and L. I. Genayeva 14 Jun. 1967 5 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Geofiz., v. 30, no. 11, 1967 p 1790–1801
(Contract NAS5-12487)
(NASA-CR-86636; ST-IM-CR-10623) CSCL 20H

It is shown that the investigation of primary cosmic radiation by the tracks of nuclear particles in meteorites and tektites is possible on the basis of the study of the depth of tracks and the results of measurements of the age of tektite hardening. Author

N67-31990*# Volt Technical Corp., Washington, D. C.
OBSERVATION OF TYPE-III RADIOBURSTS ON AIS "VENERA-2" [NABLYUDEMIYE SOLNECHNYKH VSPLESKOV RADIO-ZLUCHENIYA III TIPA NA AMS "VENERA-2"]
V. I. Slysh 29 Jun. 1967 4 p refs Transl. into ENGLISH from Astron. Zh. SSSR, v. 44, no. 3, 1967 p 487–489
(Contract NAS5-12487)
(NASA-CR-86633; ST-SP-10629) CSCL 20H

Type-III bursts of solar radioemission were observed on the AIS Venera-2 in the 985 kc and possibly in the 30 kc/sec frequencies. Estimates have been obtained of electron temperature of the outer corona and of motion velocity of the agent inducing the radioemission. Author

N67-32179 State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
ON THE ENERGY FLUXES OF LOW-ENERGY PROTONS AND POSITIVE IONS IN THE EARTH'S INNER RADIATION ZONES
L. A. Frank and R. L. Swisher Jun. 1967 12 p refs
(Grant NsG-233-62; Contract Nonr-1509(06))
(NASA-CR-86919; U. of Iowa-67-33) CFSTI: HC $3.00/MF $0.65 CSCL 20H

A search for the large energy fluxes of low-energy protons or positive ions in the earth's inner radiation zone is reported utilizing recent measurements of energy fluxes of protons and positive ions within the energy range 100 eV to 4.2 MeV with earth-satellites OGO 3 and Injun 4. Recent measurements provide upper limits for these proton and positive-ion energy fluxes which are less by factors ≈ 10 to 100 when compared to the Injun 1 observations during 1961. The upper limits strongly indicate that large energy fluxes of low-energy protons or positive ions are not a feature of the inner radiation zone. Author

N67-32187# Royal Aircraft Establishment, Farnborough (England).
SATELLITES AND CHARGED CORPUSCULAR RADIATION
M. J. Downey *In its* Spacecraft Technol. Vol. V Dec. 1966 56 p refs *Its* Lecture No. 45 (See N67-32181 18-31)

A summary of satellite measurements and the approximate physical picture of trapped radiation in the geomagnetic field are presented, followed by a more detailed discussion of theoretical aspects. Radiation measurements are reviewed which were obtained by Pioneer, Explorer, and Lunik satellites on electron and proton intensities, and on solar flare and magnetosphere phenomena. The theory of trapped radiation origin is outlined, and the recently adopted B,L coordinate system for mapping particle intensities is described. A discussion of the interaction of radiation with matter is concerned primarily with the stopping power of matter, the range of charged particles in the matter, bremsstrahlung, and laboratory simulation of radiation problems. Radiation damage effects on metals, semiconductors, glasses, and on polymer rubbers, plastics, and fluids are outlined. N.E.N.

N67-32304*# National Aeronautics and Space Administration, Washington, D. C.
MARINER V DETECTS TWO SOLAR FLARES
3 Aug. 1967 2 p
(NASA News Release-67-209) Available from the Scientific and Technical Information Division CSCL 20H

It is reported that two solar flares of medium intensity were detected by the Mariner V spacecraft en route from Earth to Venus, and that the occurrence of the flares was confirmed by monitors on Earth. C.T.C.

N67-32503# Stanford Univ., Calif. Stanford Electronics Labs.
RADIOSCIENCE
In its Quart. Status Rept., 1 Oct.–31 Dec. 1966 31 Dec. 1966 p 6–10 refs (See N67-32501 18-10)

Localized ionospheric current systems generated by winds moving across the magnetic field are considered. The electric field in the E region is assumed to be the source field, and the field strength coupled to the F region is investigated. Continuing research is reported on synchrotron noise levels resulting from electrons spiraling in the geomagnetic field. The primary investigation was on the absorption path from the synchrotron emitting electrons to the receiver, and on the absorption mechanisms. A new project of designing mode-averaging diversity combiners is also reported. The major effort centered on the initial stages of the development of a computer program to simulate the frequency-selective fading in a receiver under ionospheric conditions. N.E.N.

N67-32863# Air Force Cambridge Research Labs., Bedford, Mass.
THE OPERATING HISTORY OF THE INTERNATIONAL SOLAR FLARE PATROL, 1955–1964

Delos C. Jensen Feb. 1967 35 p
(AFCRL-67-0135; AD-652203) CFSTI: HC$3.00/MF$0.65

A decade of data on the operation of the International solar flare patrol has been collected and analyzed. These data were compiled from World Data Centers A and C, and from the individual observatories. Tests were made to correct errors introduced in the recording and handling of the data. This paper describes the data sources, error editing program employed, and the magnetic tape which has been prepared and contains the available hours of H-alpha patrol from 55 observatories for the period 1955-1964. A few tables are included showing some of the information available from the tape. Author (TAB)

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-31511*# California Univ., Berkeley. Dept. of Engineering.
AN APPLICATION OF LINEAR PROGRAMMING TO MINIMUM FUEL OPTIMAL CONTROL
C. M. Waespy May 1967 159 p refs
(Grant NsG-237-62)
(NASA-CR-86654; Rept.-67-16) CFSTI: HC $3.00/MF $0.65
CSCL 22C

The simplex method of linear programming is applied to the optimal control problem of minimum fuel. Elements of the linear programming computation method are introduced; and the simplex algorithm, duality, decomposition, and generalized programming are described from a heuristic point of view. To facilitate the description of a wide variety of associated concepts, only the minimum fuel problem is treated. The dual formulation of the linear programming problem is shown to unite some of the well-known approaches for solving linear deterministic optimal control problems. Linear programming methods are applied to the terminal homing guidance problem for spacecraft. Typical rendezvous trajectories based on linearized equations of motion are calculated. The capabilities and limitations of the linear programming method, as well as solution characteristics to the problem, are demonstrated. S.P.

N67-31548*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
OBSERVATIONS OF THE INTERPLANETARY MAGNETIC FIELD JULY 4–12, 1966
Norman F. Ness and Harold E. Taylor Jul. 1967 21 p refs
Presented at the London Cospar Proton Flare Proj., 27–28 Jul. 1967
(NASA-TM-X-55842; X-612-67-345) CFSTI: HC $3.00/MF $0.65
CSCL 22A

This report discusses simultaneous observations of the interplanetary magnetic field by three widely separated satellites: Explorers 28, 33, and Pioneer 6 during 4–12 July 1966. These data establish the general macrostructure of the field in cislunar space and include the micro-structural feature of the shock wave associated with the geomagnetic sudden commencement (SC) at 2102 on July 6, 1966. Preliminary results and analyses reveal a remarkable correspondence of the measurements by the geocentric satellites Explorers 28 and 33. The very limited data coverage by Pioneer 6 precludes a similar comparision, but is included because the satellite was separated in heliocentric longitude by +44° (with respect to the earth). Thus it provides unique data relative to the region on the Sun (N34, W45) where a class 2B flare occurred on 7 July 0022. Author

N67-31552 Smithsonian Institution, Washington, D. C.
FIVE THOUSAND- AND TEN THOUSAND-YEAR STAR CATALOGS
Gerald S. Hawkins and Shoshana K. Rosenthal 1967 38 p refs *Its* Vol. 10, No. 2

The 5000-year star catalog contains star positions at intervals of 100 years for the period −2500 to +2500 for stars with a visual magnitude brighter than +2.99. The 10,000-year star catalog is an extension of the star positions given in the 5000-year catalog and lists star coordinates at 500-year intervals for the period −10,000 to 0 (10,001 to 1 B.C.). Precession and proper motion corrections were made for listings in both catalogs. The star positions have been taken from the Fourth Fundamental Catalogue (FK4) or, if not available in the FK4, from the Smithsonian Astrophysical Observatory Star Catalog. A list of star names and standard abbreviations for the constellations are included. K.W.

N67-31786# American Science and Engineering, Inc., Cambridge, Mass.
SATELLITE AND ROCKET DATA ANALYSIS Final Report, 11 Oct. 1965–10 Oct. 1966
F. R. Paolini and G. C. Theodoridis 17 Feb. 1967 123 p refs
(Contract AF 19(628)-5712)
(ASE-1457; AFCRL-66-772; AD-649377) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. SATELLITE AND ROCKET DATA ANALYSIS 17 p refs

2. MEASUREMENTS OF 1/2 TO 4 MEV TRAPPED PROTONS IN THE EQUATORIAL MAGNETOSPHERE L. Katz, D. Smart (AFCRL), F. R. Paolini, G. C. Theodoridis, and W. C. Handley 9 p refs (See N67-31787 18-30)

3. A STUDY OF ENERGETIC ELECTRONS IN THE RADIATION BELTS WITH HITCH-HIKER I F. R. Paolini and G. C. Theodoridis 34 p refs (See N67-31788 18-30)

4. ENERGETIC ELECTRON INTENSITIES AT LOW ALTITUDES G. C. Theodoridis and F. R. Paolini 10 p ref (See N67-31789 18-30)

5. CHARGED PARTICLE TRANSMISSION THROUGH SPHERICAL PLATE ELECTROSTATIC ANALYZERS F. R. Paolini and G. C. Theodoridis 40 p refs (See N67-31790 18-14)

6. SPACE AND TIME VARIATIONS IN OUTER BELT ELECTRON SPECTRA F. R. Paolini, G. C. Theodoridis, and S. Frankenthal 9 p refs (See N67-31791 18-30)

N67-31787# American Science and Engineering, Inc., Cambridge, Mass.
MEASUREMENTS OF 1/2 TO 4 MeV TRAPPED PROTONS IN THE EQUATORIAL MAGNETOSPHERE. APPENDIX A
F. R. Paolini, G. C. Theodoridis, W. C. Hadley, L. Katz, and D. Smart (AFCRL) *In its* Satellite and Rocket Data Anal. 17 Feb. 1967 9 p refs Sponsored by AF In-House Lab. (See N67-31786 18-30)

A rocket was launched in 1965 to study the near equatorial magnetosphere up to an altitude of 18,500 km. Instrumentation included a proton spectrometer utilizing a solid-state detector and pulse height analyzer. Data are presented on the unidirectional intensities, energy spectra, and pitch angle distributions of trapped protons in the 1/2 to 4 MeV energy range. Intensity profiles at constant magnetic latitude λ derived from pitch angle distributions are also shown. The maximum perpendicular intensity observed was about 4×10^9 protons/cm^2-sec ster. at (B,L) ~ (0.006, 3.7). Energy spectra were of the shape exp $(-E/E_0)$ with $0.4 < E_0 < 0.8$ MeV. Pitch angle distributions were symmetric about maxima at 90°. Author

N67-31788# American Science and Engineering, Inc., Cambridge, Mass.

A STUDY OF ENERGETIC ELECTRONS IN THE RADIATION BELTS WITH HITCH-HIKER I, APPENDIX B

F. R. Paolini and G. C. Theodoridis *In its* Satellite and Rocket Data Anal. 17 Feb. 1967 34 p refs (See N67-31786 18-30)
(Contract AF 19(628)-5712)

A survey of relativistic electrons in the Van Allen radiation belts was performed in July and August 1963, a period of relative solar quiet, with instruments on board the polar-orbiting subsatellite Hitch-Hiker I. Perpendicular intensity maps, energy spectrums, and pitch angle distributions are presented for electrons between 0.7 and 4 MeV. Peak inner belt intensities for electrons above 1 MeV were about 5×10^6 electrons/cm^2-sec-ster (at R, $\lambda=1.35$, 0). Inner belt spectrums were consistent with an exponential shape, $\exp(-E/E_0)$, with $0.7\leq E_0\leq1.5$ MeV, although in the region (B,L) $\approx$ (0.21, 1.25) the shape was not inconsistent with a fission spectrum modified by atmospheric scattering, within the accuracy of the measurement. Maximum observed intensities of electrons above 1 MeV in the horns of the outer belt were about 10^5 electrons/cm^2-sec-ster. Outer belt intensities varied substantially, with severe depletions at times of even relatively mild magnetic and solar activity. Subsequent recoveries required periods of a few to several days, the recovery process requiring a source on the order of 10^{13} to 5×10^{13} ergs/sec at particle energies above 0.7 MeV. Outer belt spectrum shapes between 0.7 and 4 MeV were exponential with $E_0=0.35\pm0.15$ MeV. Author

N67-31789# American Science and Engineering, Inc., Cambridge, Mass.

ENERGETIC ELECTRON INTENSITIES AT LOW ALTITUDES, APPENDIX C

G. C. Theodoridis and F. R. Paolini *In its* Satellite and Rocket Data Anal. 17 Feb. 1967 10 p ref (See N67-31786 18-30)
(Contract AF 19(628)-5712)

An electron scintillation spectrometer aboard the Hitch Hiker I orbiting satellite was used to obtain energetic electron intensities. An iso-intensity contour map was constructed at a given altitude from data obtained at points of different altitudes but with identical coordinates. Maps of perpendicular electron intensities over 1 MeV are presented for various altitudes from 1000 to 100 km. Information energy spectra and pitch angle distribution are presented. Measured pitch angle distributions were consistent with expected atmospheric cutoffs, and the plateau width varied between 20 and 600 degrees. S.P.

N67-31791# American Science and Engineering, Inc., Cambridge, Mass.

SPACE AND TIME VARIATIONS IN OUTER BELT ELECTRON SPECTRA, APPENDIX E

F. R. Paolini, G. C. Theodoridis, and S. Frankenthal *In its* Satellite and Rocket Data Anal. 17 Feb. 1967 9 p refs (See N67-31786 18-30)
(Contract AF 19(628)-5712)

The temporal and spatial variations of the spectra of outer belt electrons with energies exceeding 1 MeV were observed. These variations have been correlated qualitatively with variations in the perpendicular intensity and in the geomagnetic activity. Two extreme patterns of spatial dependence of the spectra can be discerned: spectra which soften monotonically with L in a manner consistent with radial diffusion, and spectra which are considerably harder and nearly independent of L beyond 4, suggesting the action of local acceleration mechanisms and/or preferential dumping of low energy electrons. Data were obtained from a scintillation spectrometer flown on the satellite Hitch-Hiker I, from both day and night portions of the orbit for L less than approximately 6; hence, diurnal variations were unimportant. The satellite orbit was approximately polar, with an inclination of 82°; the angle between the orbit's ascending node and the earth-sun line was about 62°. Perigee was 228 km, and apogee was 4150 km. Author

N67-31796# Smithsonian Astrophysical Observatory, Cambridge, Mass.

ASTRONOMICAL PAPERS TRANSLATED FROM THE RUSSIAN, NO. 8

[1967] 39 p refs
(SAO-611-40) CFSTI: HC$3.00/MF$0.65

CONTENTS:

1. MEASUREMENT OF RELATIVE OSCILLATOR STRENGTHS IN THE ARC SPECTRUM OF IRON BY THE EMISSION METHOD N. G. Morozova, G. P. Startsev, and M. S. Frish p 1–11 refs (See N67-31797 18-30)

2. LINE STRENGTHS IN INTERMEDIATE COUPLING FOR FE II P. G. Gruzdev p 13–18 refs (See N67-31798 18-30)

3. INHOMOGENEOUS VECTOR COUPLINGS IN ATOMIC SPECTRA A. M. Gutman and I. B. Levinson p 20–25 refs (See N67-31799 18-30)

4. THE PROBLEM OF THE FORMATION OF STARS S. A. Kaplan p 27–31 refs (See N67-31800 18-30)

N67-31797# Smithsonian Astrophysical Observatory, Cambridge, Mass.

MEASUREMENT OF RELATIVE OSCILLATOR STRENGTHS IN THE ARC SPECTRUM OF IRON BY THE EMISSION METHOD

N. G. Morozova, G. P. Startsev, and M. S. Frish *In its* Astron. Papers Transl. from the Russ., No. 8 1967 p 1–11 refs Submitted for publication (See N67-31796 18-30)

Relative oscillator strengths in the arc spectrum of iron have been measured from spectral-line intensities with the purpose of supplementing and making more accurate the available data. The spectra were photographed in the first order of a spectrograph having a plane diffraction grating (dispersion 2 Å/mm). A direct-current arc at 250 to 300 volts served as the excitation source. The conditions of the discharge were chosen to eliminate the distorting influence of self-absorption on the spectral-line intensities. A fairly sensitive criterion for the absence of self-absorption is the constancy of the relative intensities of lines in a given multiplet with a change in the concentration of iron atoms in the discharge. An estimate of the self-absorption was also made by examining the dependence of $\log(J/J_0)$ on $\log(J_0)$, where J is the line intensity under the given conditions, and J_0 is the line intensity in the absence of self-absorption. The relative values of J_0 for a given multiplet were determined by taking into account the arc temperature and using the oscillator strengths measured by King. Self-absorption was also checked by examining the broadening of the spectral lines with a Fabry–Perot etalon. Author

N67-31798# Smithsonian Astrophysical Observatory, Cambridge, Mass.

LINE STRENGTHS IN INTERMEDIATE COUPLING FOR FE II

P. F. Gruzdev *In its* Astron. Papers Transl. from the Russ., No. 8 1967 p 13–18 refs Submitted for publication (See N67-31796 18-30)

Relative line strengths were calculated for the $3d^6(a^5D)4s$–$3d^6(a^5D)4p$ array in Fe II. The required energy matrices for the configurations $3d^6(a^5D)4s$ and $3d^6(a^5D)4p$ were built by adding the appropriate electrostatic energies to the diagonal elements of the matrices of spin–orbit interaction. The spin–orbit parameters characterizing the centers of gravity of the terms (I) were determined so that the calculated energy levels and Lande g-factors closely agreed with the experimental values of these quantities. The values of these parameters were used to set up secular equations. Their solutions were used to find the transformation coefficients from the LS coupling scheme to the intermediate coupling scheme. The transformation was then conducted for the relative line strengths. The relative line strengths

for the above mentioned array are tabulated for both LS and intermediate coupling and show that for transitions permitted in LS coupling, the line strengths calculated in intermediate coupling are generally close to the line strengths in LS coupling, although some lines show sizeable divergencies. R.N.A.

N67-31799# Smithsonian Astrophysical Observatory, Cambridge, Mass.
INHOMOGENEOUS VECTOR COUPLINGS IN ATOMIC SPECTRA
A. M. Gutman and I. B. Levinson *In its* Astron. Papers Transl. from the Russ., No. 8 1967 p 20–25 refs Submitted for publication (See N67-31796 18-30)

Possible vector couplings of atomic spectra can be treated by successively diagonalizing the matrices of the Hamiltonian in order of their decreasing contribution to the total energy. By examining the $f^n l'$ configuration in this way, six coupling schemes are found which are theoretically possible. In addition to the two homogeneous coupling and the three generalized jl- and lj-couplings, an LS_O-coupling also exists. The occurrence of inhomogeneous couplings requires that the exchange interaction of the outer electron with the core be small. This condition is met when the outer electron is highly excited, notably when l' is large. The Jl-, LS_O-, and jl-couplings are characterized by paired energy levels. This structure is due to the outer electron spin. The intermediate quantum number K in these couplings is more exact when the influence of the outer electron spin is less on these couplings. The classification of $2p^2(^3P)4f$ O II using both Jl- and LS-coupling is tabulated. The Jl classification is confirmed by calculating the levels in both LS and Jl schemes. A particular case where the use of the jl-coupling scheme is not warranted is discussed. R.N.A.

N67-31800# Smithsonian Astrophysical Observatory, Cambridge, Mass.
THE PROBLEM OF THE FORMATION OF STARS
S. A. Kaplan *In its* Astron. Papers Transl. from the Russ., No. 8 1967 p 27–31 refs Submitted for publication (See N67-31796 18-30)

Consideration is given to a scheme of evolution for stars of the upper main sequence in which stars newly formed in O and B associations enter the main sequence in some region and evolve along it with decreasing mass and luminosity due to corpuscular radiation. Assuming that newly formed stars of the upper main sequence enter at one place and that the loss of mass for a star is proportional to its luminosity, Paranago derived the theoretical expression for the luminosity function and compared it with observations. The resulting theoretical luminosity function was agreed well with observations in the interval of bolometric magnitude M from +4 to +8. In the interval $-8<M<-4$ the observed luminosity function is lower and falls off far more steeply than that of Paranago. This discrepancy arises because stars evolve onto the upper main sequence not at one place but over some interval of absolute bolometric magnitude. A method is presented for determining with what absolute bolometric magnitude and in what proportions newly formed stars of different spectral type and luminosities enter the upper main sequence. R.N.A.

N67-31810*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EARLY RESULTS FROM THE MAGNETIC FIELD EXPERIMENT ON LUNAR EXPLORER 35
N. F. Ness, K. W. Behannon, C. S. Scearce, and S. C. Cantarano Jul. 1967 32 p refs
(NASA-TM-X-55847; X-612-67-388) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Explorer 35 was injected into a selenocentric orbit on July 22, 1967. Analysis of measurements near pericynthion (2900 km) while the moon is within the geomagnetic tail suggest that the moon is not magnetized and that its moment is less than 4×10^{20} cgs. units (10^{-5} of the earth). Rapid diffusion of interplanetary magnetic field lines through the lunar body limits the average electrical conductivity to a maximum value of 10^{-5} mhos/meter. Thus capture of interplanetary magnetic field lines by the moon and formation of a lunar magnetosphere as theorized is not substantiated. A lunar bow shock wave has not yet been observed when the moon is located in the interplanetary medium or the magnetosheath of the earth. Author

N67-31811*# California Univ., San Diego.
COSMIC DUST IN THE STRATOSPHERE
James R. Arnold, Narendra Bhandari, and David W. Parkin [1967] 30 p refs
(Grant NsG-321)
(NASA-CR-86624) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A balloon borne technique for stratospheric collection of micron size dust from up to a million cubic meters of air has been developed. The technique samples particles in size range of roughly 1–100 microns and thus the extraterrestrial particles in this size range which do not burn up during their entry in the earth's atmosphere are collected. The collection made during the maximum activity of early June meteor showers in 1966, indicates that the total terrestrial accretion in this size range certainly does not exceed 550 tons per day and is probably less than 50 tons per day over the whole earth. Author

N67-31825# Royal Astronomical Society, London (England).
MEMOIRS OF THE ROYAL ASTRONOMICAL SOCIETY, VOLUME 71, PART 1
1967 47 p refs

CONTENTS:

1. FREE–FREE ABSORPTION COEFFICIENTS FOR NON-HYDROGENIC ATOMS G. Peach p 1–11 refs (See N67-31826 18-30)

2. A REVISED GENERAL FORMULA FOR THE CALCULATION OF ATOMIC PHOTOIONIZATION CROSS SECTIONS G. Peach p 13–27 refs (See N67-31827 18-30)

3. TOTAL CONTINUOUS ABSORPTION COEFFICIENTS FOR COMPLEX ATOMS G. Peach p 29–45 refs (See N67-31828 18-30)

N67-31826# Royal Astronomical Society, London (England).
FREE–FREE ABSORPTION COEFFICIENTS FOR NON-HYDROGENIC ATOMS
G. Peach *In its* Mem. of the Roy. Astron. Soc., Vol. 71, Pt. 1 1967 p 1–11 refs (See N67-31825 18-30)

Free–free absorption coefficients are calculated for H, He, He^+, Li, C, N, O, Ne, Mg, Mg^+, Al, Si, Cl, K and Ca^+. In the case of a hydrogenic atomic system, the total free–free absorption coefficient may be evaluated exactly, assuming that a Maxwell distribution is valid for the initial energy of the free electron. For all the other atoms considered, a correction term is added to the hydrogenic coefficient, which takes account of deviations from the hydrogen-like continua for low values of the angular momentum. This correction term is obtained by using the general formula developed by the author for the individual free–free transition cross sections and summing over the relevant values of angular momentum. Author

N67-31827# Royal Astronomical Society, London (England).
A REVISED GENERAL FORMULA FOR THE CALCULATION OF ATOMIC PHOTOIONIZATION CROSS SECTIONS
G. Peach *In its* Mem. of the Roy. Astron. Soc., Vol. 71, Pt. 1 1967 p 13–27 refs (See N67-31825 18-30)

The formula was modified to reduce error in regions where the amplitude and phase factors were obtained by extrapolation. The radial integrals are recomputed directly, and the evaluation

and behavior of the integrals are discussed. Revised data on the amplitude and phase factors are also presented. Photoionization cross sections are included for He, Li, and Na. N.E.N.

N67-31828# Royal Astronomical Society, London (England).
TOTAL CONTINUOUS ABSORPTION COEFFICIENTS FOR COMPLEX ATOMS
G. Peach *In its* Mem. of the Roy. Astron. Soc., Vol. 71, Pt. 1 1967 p 29–45 refs (See N67-31825 18-30)

Continuous absorption coefficients, in which both the bound–free and free–free contributions are included, are calculated for C, N, O, Mg, Mg^+, Si, Cl and Ca^+. A Boltzmann distribution is assumed for the relative populations of the discrete energy levels, and for the continuum states the absorbing electron has a Maxwell energy distribution. The present results for nitrogen and oxygen give improved agreement with experiment in the spectral region 4300–6300 Å as compared with earlier calculations. The agreement with the experimental data for chlorine in the regions 2800–5400 Å is less satisfactory. Author

N67-31836*# Volt Technical Corp., Washington, D. C.
INVESTIGATION OF REFLECTIONS BY THE MOON'S SURFACE OF METER RADIOWAVES [ISSLEDOVANIYE OTRAZHENIY METROVYKH RADIOVOLN POVERKHNOST'YU LUNY]
O. I. Yakovlev and A. I. Yefimov 16 Jun. 1967 4 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 3 p 583–584
(Contract NAS5-12487)
(NASA-CR-86662; ST-LPS-RWR-10626) CFSTI: HC $3.00/MF $0.65 CSCL 20N

Results of measurements of the reflection and scattering of radiowaves with $\lambda \approx 1.7$ m performed in September 1966 on the AMS Luna-11, are described. The dependency of the reflection factor on the sliding angle permitted data on the dielectric constant of lunar rocks to be obtained. A more extended report is to be presented elsewhere. Author

N67-31842*# Planning Research Corp., Los Angeles, Calif.
RISK ESTIMATING TECHNIQUES FOR UNMANNED SPACE MISSIONS: AN EXPLORATORY STUDY Final Report
F. E. Hoffman, G. W. S. Johnson, and L. H. Simonsen 19 May 1967 98 p refs Prepared for JPL
(Contract NAS7-100; Contract JPL-951778)
(NASA-CR-86665; PRC-R-969) CSCL 14D

The results of a small exploratory study on the development of a risk model for unmanned space exploration missions are presented. Risk is defined as the degree of exposure to failure in meeting the program objectives. The model has been calibrated and demonstrated using the Mariner IV mission in 1964 and a future mission using a Mars Orbiter/Lander in 1973 and 1975. The model allows for risk reduction in a multiple-launch program. Various system design candidates and spacecraft subsystem design options can be evaluated to provide quantification of risk with varying inputs. These inputs include schedule, number of spacecraft per launch, number of launches, sterilization intensity, and level of combined system testing. Author

N67-31846 Lockheed Missiles and Space Co., Sunnyvale, Calif.
VARIATIONAL PROBLEMS OF SPACE FLIGHT MECHANICS
G. L. Grodzovskii [1967] 22 p refs Transl. into ENGLISH of the 17th Japan. Rocket Soc. Meeting held in Tokyo, May 1967

The influence of weight constraints on the optimal motion parameters of a variable mass body in a gravitational field is considered. The optimum motion of outflow-velocity limited, power limited with substance accumulation, and thrust limited engine systems is investigated. Examples are presented of the solution of model problems. At the same time, the problem of selecting the optimum weight parameters, the optimum control of the engine system, and the determination of the optimum trajectories as a whole, is solved. Author

N67-31851*# Scientific Translation Service, La Canada, Calif.
POSSIBLE STRUCTURE OF LUNAR SURFACE LAYER [O VOZMOZHNOY STRUKTURE POVERKHNOSTNOGO SLOYA LUNY]
G. N. Dul'nev, Yu. P. Zarichnyak, and B. L. Muratova Washington, NASA, Jul. 1967 12 p refs Transl. into ENGLISH from Izv. Vyssh. Uchеb. Zaved., Radiofiz. (Gor'kiy), v. 9, no. 5, 1966 p 849–858
(Contract NASw-1496)
(NASA-TT-F-11071) CSCL 22A

The analytical expression for the effective thermal conductivity of bodies with a different structure is established. The solution of the opposite problem is investigated—determination of the body structure based on the effective thermal conductivity coefficient. Ideas on the possible structure of the lunar surface layer are presented. These ideas are based on an analysis of radio astronomical data on the magnitude of the parameter $\gamma = (\gamma \rho c)^{-1/2}$ and certain additional assumptions. Author

N67-31860*# American Science and Engineering, Inc., Cambridge, Mass.
RESULTS OF A SOUNDING ROCKET EXPERIMENT TO STUDY CELESTIAL X-RAY SOURCES Final Report
H. Gursky, R. Giacconi, P. Gorenstein, and J. R. Waters Jun. 1967 37 p refs
(Contract NASw-1535)
(NASA-CR-85787; ASE-1637) CFSTI: HC $3.00/MF $0.65 CSCL 03A

In consonance with the program objective to study celestial X-ray sources with instrumentation of high intrinsic angular resolution, the Crab Nebula individual X-ray source was examined with high-resolution instruments. Technical data are presented on the experiment performed from an Aerobee rocket flown from the White Sands Missile Range, as well as the payload developed. Observational data on the Crab indicate that the spectral line radiation comes from a series of filaments that appear to encompass the region. The continuum radiation is highly polarized, in certain regions by as much as 20% and even averaged over the entire nebula, the degree of polarization being 7%. Dynamic light ripples (regions of enhanced surface brightness) are seen to traverse the central region of the nebula in times of the order of several months. In radio, the Crab appears to be about the same size as in visible. The radio emission from the Crab is observed to be polarized. R.Li.

N67-31934*# Geological Survey, Washington, D. C.
ASTROGEOLOGIC STUDIES. PART A: LUNAR AND PLANETARY INVESTIGATIONS Annual Progress Report, 1 Jul. 1965–1 Jul. 1966
Dec. 1966 417 p refs
(NASA Order R-66)
(NASA-CR-86649) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Reports on lunar maps, geologic studies, and on lunar and planetary physics are presented. For individual titles see N67-31935–N67-31955.

N67-31935*# Geological Survey, Washington, D. C.
SUMMARY OF THE GEOLOGY OF THE PITATUS REGION OF THE MOON
N. J. Trask and S. R. Titley *In its* Astrogeol. Studies, Part A Dec. 1966 p 3–9 refs (See N67-31934 18-30)

Summarized are data on the stratigraphy and structure of the Pitatus region of the moon. S.C.W.

N67-31936*# Geological Survey, Washington, D. C.
THE GEOLOGY OF THE MARE SERENITATIS REGION OF THE MOON
M. H. Carr *In its* Astrogeol. Studies, Part A Dec. 1966 p 11–16 refs (See N67-31934 18-30)

Summarized are data on the stratigraphy and structure of the Mare Serenitatis region of the moon. S.C.W.

N67-31937*# Geological Survey, Washington, D. C.
GEOLOGIC HISTORY OF THE MARE HUMORIUM REGION OF THE MOON
S. R. Titley *In its* Astrogeol. Studies, Part A Dec. 1966 p 17–21 refs (See N67-31934 18-30)

A discussion of the geologic history of the Mare Humorum region of the moon is presented and events leading to its formation are reviewed. S.C.W.

N67-31938*# Geological Survey, Washington, D. C.
SUMMARY OF THE GEOLOGY OF THE HEVELIUS REGION OF THE MOON
J. F. Mc Cauley *In its* Astrogeol. Studies, Part A Dec. 1966 p 23–29 refs (See N67-31934 18-30)

Summarized are data on the stratigraphy, structure, and geologic history of the Hevelius region of the moon. A brief discussion of the Luna 9 landing site is included and speculation is made concerning the vicinity of the moon on which it landed. S.C.W.

N67-31939*# Geological Survey, Washington, D. C.
SUMMARY OF THE GEOLOGY OF THE COPERNICUS QUADRANGLE OF THE MOON
H. H. Schmitt, N. J. Trask, and E. M. Shoemaker *In its* Astrogeol. Studies, Part A Dec. 1966 p 31–39 refs (See N67-31934 18-30)

Geologic data on the Copernicus quadrangle of the moon are summarized; and stratigraphic characteristics of the complete quadrangle, the crater Copernicus, and the dark halo craters are discussed. S.C.W.

N67-31940*# Geological Survey, Washington, D. C.
SUMMARY OF THE GEOLOGY OF THE SELEUCUS QUADRANGLE OF THE MOON
H. J. Moore *In its* Astrogeol. Studies, Part A Dec. 1966 p 41–50 refs (See N67-31934 18-30)

Geologic data on the time-stratigraphic units of the Seleucus quadrangle of the moon are summarized. Analyzed are the pre-Imbrian units; the rock stratigraphic units spanning the Imbrian and Eratosthenian systems; rock-stratigraphic units spanning the Eratosthenian and Copernican systems; and lineations and faults present in the Aristarchus plateau. S.C.W.

N67-31941*# Geological Survey, Washington, D. C.
GEOLOGY OF THE JULIUS CAESAR AND MARE VAPORUM QUADRANGLES
Don E. Wilhelms and Elliot C. Morris *In its* Astrogeol. Studies, Part A Dec. 1966 p 51–62 refs (See N67-31934 18-30)

Data on the stratigraphy and structure of the Julius Caesar and Mare Vaporum quadrangles are summarized. Described are: plains-forming materials; terra-mantling materials; materials with irregular surfaces; crater materials; concentric structures associated with the dominant basin structures in the two quadrangles; radial scarps and troughs; and minor structures consisting mainly of rilles (probably grabens) and some mare regions. The geologic history of the two quadrangles is also discussed. S.C.W.

N67-31942*# Geological Survey, Washington, D. C.
A COMPARISON OF TWO TERRESTRIAL GRABENS WITH THE LUNAR RILLES RIMA ARIADAEUS AND RIMAE HYPATIA I AND II
George I. Smith *In its* Astrogeol. Studies, Part A Dec. 1966 p 65–85 refs (See N67-31934 18-30)

Photogeologic maps were made of the fault systems related to two Quaternary grabens and were compared with maps of the inferred fault patterns in the vicinity of the lunar rilles Rima Ariadaeus and Rimae Hypatia I and II. Related characteristics of the lunar and terrestrial features are compared and on the basis of these data an attempt is made to determine tectonic origin. S.C.W.

N67-31943*# Geological Survey, Washington, D. C.
SEISMIC ENERGY AS AN AGENT OF MORPHOLOGIC MODIFICATION ON THE MOON
S. R. Titley *In its* Astrogeol. Studies, Part A Dec. 1966 p 87–103 refs (See N67-31934 18-30)

A discussion of the endogenous seismicity of the moon and its possible role in producing morphological features and modifications of the lunar surface is presented. Surface seismic effects on the Earth and their relationship to those occurring on the Moon are also analyzed. Considered are the phenomena of compaction, slope failure or landslides, and debris creep. On the basis of comparison with terrestrial processes, it is concluded that: (1) seismic activity should be sufficient to produce many of the morphological features and modifications shown in Ranger and Surveyor I photographs; and (2) seismic activity may be a major modifying agent, although not necessarily the dominant one, and together with erosion by particles, may produce many of the features observed on the lunar surface. S.C.W.

N67-31944*# Geological Survey, Washington, D. C.
PRELIMINARY REPORT ON THE GEOLOGY OF THE PLATO QUADRANGLE OF THE MOON
J. W. M'Gonigle and D. L. Schleicher *In its* Astrogeol. Studies, Part A Dec. 1966 p 105–114 refs (See N67-31934 18-30)

Data on the morphological rock units, structure, and geologic history of the Plato quadrangle of the moon are summarized. S.C.W.

N67-31945*# Geological Survey, Washington, D. C.
PRELIMINARY GEOLOGIC SUMMARY OF THE CASSINI QUADRANGLE OF THE MOON
Norman J. Page *In its* Astrogeol. Studies, Part A Dec. 1966 p 115–121 refs (See N67-31934 18-30)

Stratigraphic relations and structural features of the Cassini quadrangle of the Moon are briefly described, and features that differ from previously described lunar relations and features are emphasized. S.C.W.

N67-31946*# Geological Survey, Washington, D. C.
PROBABLE IGNEOUS RELATIONS IN THE FLOOR OF THE CRATER J. HERSCHEL
G. E. Ulrich *In its* Astrogeol. Studies, Part A Dec. 1966 p 123–132 refs (See N67-31934 18-30)

Structural features in the floor of the crater J. Herschel are analyzed and an attempt is made to interpret observed features on the basis of a possible volcanic origin. S.C.W.

N67-31947*# Geological Survey, Washington, D. C.
STRUCTURE OF THE TRIESNECKER–HIPPARCHUS REGION
T. W. Offield *In its* Astrogeol. Studies, Part A Dec. 1966 p 133–153 refs (See N67-31934 18-30)

More than 800 linear structures, including straight segments of curved lineaments, have been identified and measured in the Triesnecker–Hipparchus region near the center of the earthside hemisphere of the moon. The most common features are straight valleys between nearly linear ridges and the basis of straight escarpments. Other lineaments include rills, chain craters, mare ridges, and polygonal crater rims. Structural patterns observed are

described and probable relationships of the local lineaments to distant mare basins, to a suggested lunar grid and to other regional structures, are defined and interpreted. S.C.W.

N67-31948*# Geological Survey, Washington, D. C.
THE THEORY OF RADIATIVE TRANSFER IN THE LUNAR SURFACE
Robert L. Wildey *In its* Astrogeol. Studies, Part A Dec. 1966 p 157–162 refs (See N67-31934 18-30)

Limitations of previously proposed methods for explaining infrared observations of the temperature variations of the lunar surface in terms of heat flow analysis are discussed. It is noted that the need for improvement of the theory of the heat flow of the lunar surface is independently founded on its failure to correctly predict recent infrared observations of lunar night-time cooling, even when temperature dependent conductivity and two layered models are used. A modified version of the fundamental equation of radiative transfer is developed for prescribing the behavior of the infrared radiation recorded on earth. It is concluded that the most satisfactory technique of solution appears to lie in the application of Chandrasekhar's method of discrete directional beams in Gaussian quadrature, so that the integro-differential equation will be replaced by a large number of simultaneous partial differential equations. S.C.W.

N67-31949*# Geological Survey, Washington, D. C.
MAXIMUM POLARIZATION VALUES OF SOME LUNAR GEOLOGIC UNITS
N. J. Trask *In its* Astrogeol. Studies, Part A Dec. 1966 p 163–167 refs (See N67-31934 18-30)

Tabulated are maximum polarization values of lunar geologic units that were mapped on the basis of observations from earth. On the basis of data accumulated over a two year period it is generalized that: (1) bright rays and the bright floors of some craters have the lowest values of maximum polarization (from 3.5 to 6.0%); (2) maximum polarization values of light terra plains forming materials, such as the Cayley Formation, range from 5.0 to 6.5%; (3) maximum polarization values of regional units surrounding some circular mare basins, such as the Fra Mauro Formation around the Imbrium basin, range from 6.0 to 8.5%; and (4) maximum polarization values of dark mare materials of the Procellarum Group and local dark covering materials younger than the Procellarum, such as the Doppel-mayer Formation, are the highest and cover the greatest range (9.0 to 15.0%). A brief study of the crater Dawes was also made. It was found that the polarization of Dawes was not anomalous, and that the albedo and maximum polarization of the rim of the crater were almost the same as that of the surrounding mare material. S.C.W.

N67-31950*# Geological Survey, Washington, D. C.
SPATIAL FILTERING OF ASTRONOMICAL PHOTOGRAPHS
Robert L. Wildey *In its* Astrogeol. Studies, Part A Dec. 1966 p 169–181 refs (See N67-31934 18-30)

The applicability of Fourier transform techniques to problems of astronomical imagery is discussed, and an auxiliary device which destroys the coherence of laser light while preserving its plane waveform is described. The device consists of a Dove prism mounted in a cylinder and rotated by an oblique feed of compressed air. A stationary beam entering one end of the prism emerges from the other end with a rotational velocity twice that of the prism. The device destroys the coherence of the light for time intervals of the order of many prism revolutions or longer because (1) the optical figure of the prism is not perfect, and (2) the rotational motion of the device is not smooth to the extent of being without positional perturbations of the order of a fraction of the wavelength of light or larger. The perturbations considered do not constitute a severe departure from plane waveform. Thus, the optical system continues to operate as it should, except that all lenses have transfer functions without discontinuities so that the Fourier series representations of the images have higher harmonics attenuating to zero even after truncation and thus do not show ringing. An example of the success with which the device destroys coherence, and thus facilitates the application of spatial filtering to astronomical photographs, is included. S.C.W.

N67-31951*# Geological Survey, Washington, D. C.
APPLICATION OF MOIRE PATTERNS TO LUNAR MAPPING
David Cummings and H. A. Pohn *In its* Astrogeol. Studies, Part A Dec. 1966 p 183–187 refs (See N67-31934 18-30)

Moire patterns produced by superposed screens were used to analyze photographs of certain parts of the southern lunar highlands region which were covered by the following plains-forming units: (1) a smooth unit, (2) a pitted unit, and (3) a sculptured-plains unit. Focused on was the feasibility of using moire patterns in the study of lineaments on lunar photographs. It is shown that these patterns can be used for easy and rapid examination of lunar photographs to determine the presence of subtle lineaments. The advantage of this method is apparent where many photographs must be examined in a relatively short period of time. The method can also be used for interpretation of terrestrial photographs. S.C.W.

N67-31952*# Geological Survey, Washington, D. C.
THE PROCESSING OF PHOTOCLINOMETRIC DATA
Alexander J. Swartz *In its* Astrogeol. Studies, Part A Dec. 1966 p 189–193 refs (See N67-31934 18-30)

A program focusing on the development of an improved system for processing photoclinometric data is reported. The primary goal of this system is to maximize the ratio of work done by the computer relative to manual reduction. Efforts to improve rapid processing techniques required to handle the large amounts of data available are described. Emphasized is an approach which involves the use of photometric scanning of the reconstructed photographs along phase lines to obtain data. Improvements to this technique are discussed. Also discussed are programming difficulties stemming from differences in the isodensitracer magnetic tape output format and the input format required by the Fortran computer language; the use of a table look-up procedure in mapping via the photometric function; inherent problems associated with the manipulation of data by technical personnel; and the development of a device called a programmed light source for spatial microphotometry applications. S.C.W.

N67-31953*# Geological Survey, Washington, D. C.
THE NOCTURNAL HEAT SOURCES OF THE SURFACE OF THE MOON
Robert L. Wildey *In its* Astrogeol. Studies, Part A Dec. 1966 p 195–209 refs (See N67-31934 18-30)

A map of the thermal surface brightness of lunar regions darkward of the sunset terminator, together with a positional chart of a large number of nighttime hotspots, has recently been made by telescopic reconnaissance in the 8–14 μ region. Nine additional thermal anomalies and a morphological analysis of the signal properties of these anomalies are presented here. The extraction of information by this process has been carried to the limit allowed by system noise. Attempts to regain the cooling curves of anomalies themselves provide information suggestive that the anomalies are not all volcanic, a fact previously suspected but never observed directly. In addition it may be concluded that two categories of anomalies are present on the Moon's dark side, not including false anomalies of the delayed sunset type in which surface prominences are illuminated for some time after sunset on the surrounding lowlands. Author

N67-31954*# Geological Survey, Washington, D. C.
A PHOTOELECTRIC-PHOTOGRAPHIC MAP OF THE NORMAL ALBEDO OF THE MOON

Howard A. Pohn and Robert L. Wildey *In its* Astrogeol. Studies, Part A Dec. 1966 p 211–234 refs (See N67-31934 18-30)

Described is a map which is the first reliable map of the absolute normal albedo of the moon in which real time photoelectric calibration is used, and for which the necessary uniformity in plate parameters is known. The map is considered preliminary for two reasons: (1) the absolute scale of normal albedo may undergo a blanket correction factor of the order of a few percent difference from the present data owing to a refinement in absolute calibration presently under study; and (2) the brightness gradients of very small bright lunar features, such as some bright halo craters, are too steep to have been followed, and the peak values indicated are too low by an uncertain amount. S.C.W.

N67-31955*# Geological Survey, Washington, D. C.
SUMMARY OF TELESCOPIC LUNAR STRATIGRAPHY
Don E. Wilhelms *In its* Astrogeol. Studies, Part A Dec. 1966 p 237–305 refs (See N67-31934 18-30)

This paper summarizes the results of the lunar geologic mapping program of the U.S. Geological Survey as of mid-1966, when 28 quadrangles in the equatorial belt had been mapped by telescopic means at a scale of 1:1,000,000 and before mapping had begun at larger scales from photographs by unmanned lunar orbiters. The principles underlying lunar geologic mapping are discussed and an answer offered to the often asked question of how such mapping can be done before man sets foot on the Moon. Also discussed are nearly all stratigraphic units appearing on the published and preliminary maps produced and it is shown how the aforementioned general principles are applied in recognizing, defining, and naming individual units and placing them in order of relative age. The history and origin of these stratigraphic units as they were interpreted in mid-1966 is summarized. Author

N67-31987*# Volt Technical Corp., Washington, D. C.
ON SOME MODELS OF ZODIACAL CLOUD
N. B. Divari 20 Jun. 1967 10 p refs Transl. into ENGLISH from Astron. Vestn., v. 1, no. 2, 1967 p 103–109
(Contract NAS5-12487)
(NASA-CR-86679; ST-IM-CG-10625) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Certain models of heliocentric cloud are considered. Starting from the distribution of orbit inclinations of dust particles, which are analogous to orbit distributions of comets, asteroids and meteors, the concentration $F(r, \phi)$ of a dust cloud is computed for each model as a function of the distance r from the sun and of the heliocentric latitude ϕ. The functions $F(r, \phi)$, obtained for each model, were used for the calculation of brightness of zodiacal light. Comparison of the so computed brightnesses with those observed shows that the distributions corresponding to asteroids, periodic comets, as well as to hyperbolic comets cannot be taken for the zodiacal cloud. Two models: the meteoric and the cometary, including both the periodic and hyperbolic orbits, assure a sufficiently good agreement with observations. The calculated dependence of the degree of polarization on the distance from the sun in the ecliptic is found to be sufficiently similar to that observed for all models. It should be noted that there are specific difficulties from the point of view of cosmogony linked with the explanation of zodiacal cloud existence at the expense of disintegration of periodical comets and meteors. Author

N67-32038*# National Aeronautics and Space Administration, Washington, D. C.
METEOR ORBITS AND DUST
Gerald S. Hawkins, ed. (Smithsonian Astrophys. Obs.) 1967 437 p refs Proc. of a Symp. held in Cambridge, Mass., 9–13 Aug. 1965; sponsored by NASA and the Smithsonian Inst. *Its* Smithsonian Contrib. to Astrophys. Vol. 11
(NASA-SP-135) GPO: HC $2.50; CFSTI: MF $0.65 CSCL 03B

Papers on photographic and radar observations of meteors, meteor stream parameters, the zodiacal light, satellite data on meteoric dust, and spherules are presented. For individual titles see N67-32039–N67-32085.

N67-32039*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SELECTED RESULTS FROM PRECISION-REDUCED SUPER-SCHMIDT METEORS
L. G. Jacchia, F. Vamiani, and R. E. Briggs *In* NASA. Washington Meteor Orbits and Dust 1967 p 1–7 refs (See N67-32038 18-30)

A general analysis of the atmospheric trajectories of 413 precisely reduced Super-Schmidt photographic meteors were completed. The results obtained mainly concern physical characteristics of meteors. Only a few of the results are mentioned, namely, physical differences dependent on the type of orbit, peculiarities of individual showers, and the mass scale for photographic meteors. Meteors with abrupt beginnings appear at a height where the atmospheric density ρ is such that ρv^3 is a constant (v = meteor velocity); this result suggests that heating rather than aerodynamic pressure is the trigger mechanism in the breakup of such objects. Author

N67-32040*# Slovak Academy of Sciences, Bratislava (Czechoslovakia). Astronomical Inst.
RELATION OF METEOR ORBITS TO THE ORBITS OF COMETS AND ASTEROIDS
L. Kresak *In* NASA. Washington Meteor Orbits and Dust 1967 p 9–34 refs (See N67-32038 18-30)

The distribution of the orbits of asteroids, short-periodic comets, and meteors is investigated using a series of diagrams with semimajor axis plotted against eccentricity, designed for particular values of inclination. This kind of representation allows a number of significant quantities and conditions to be interrelated and compared with observations. Empirical comet–asteroid criteria are discussed, and the evolutionary paths, resulting from the perturbations by Jupiter, asteroidal collisions, and the drag effects of solar radiation, are computed. The selection effects inherent in the discovery, or observation, of individual categories of objects are evaluated as functions of the position within the diagram, and the observing data are converted into the probable virtual distributions. All known orbits of the asteroids and short-periodic comets and all available photographic meteor orbits are used for this purpose. The comparison of the corrected distributions and the consideration of potential evolutionary effects suggest that there are five distinct classes of meteor orbits, generically related to comets or asteroids as parent bodies, which are concentrated in different regions of the diagram. Author

N67-32041*# Czechoslovak Academy of Sciences, Ondrejov. Astronomical Inst.
CLASSIFICATION OF METEOR ORBITS
Z. Ceplecha *In* NASA. Washington Meteor Orbits and Dust 1967 p 35–60 refs (See N67-32038 18-30)

An additional double maximum distribution parameter is used together with the orbital elements. Four groups are found among sporadic meteors: the A group has the greatest density and short-period orbits with small eccentricities and ecliptical concentration; the C group has the least density and can be separated into a C_1 group of short-period orbits with ecliptical concentration but with longer semimajor axes and with greater eccentricities than the A group, and into a C_2 group with long-period orbits of eccentricities near one and without any ecliptical or other concentration. The B group has a density between that of the A and the C groups, and short-period orbits with great eccentricities, small perihelion distances and ecliptical concentration. The C_1 group is clearly connected with short-period comets, the C_2 group with the long-period parabolic comets. The B group

could be connected with the short-period comets. The A group is probably connected with asteroids. The observed number of Super-Schmidt meteors is maximal in the A group, a little less in the C group (the C_2 group being a greater contributor than the C_1 group), and only small in the B group. Author

N67-32042*# Academy of Sciences of the Tajik SSR, Doushanbe (USSR). Astrophysical Inst.

ORBITS OF BRIGHT PHOTOGRAPHIC METEORS

P. B. Babadzhanov and E. N. Kramer (Odessa State Univ.) *In* NASA, Washington Meteor Orbits and Dust 1967 p 67–80 refs (See N67-32038 18-30)

The distributions of orbital elements of bright meteors ($M<1$ mag), which were photographed in 1957–1963 in Dushanbe and Odessa, are studied. It is concluded that bright meteors move in more eccentric orbits than faint meteors, which were photographed by Baker Super-Schmidt cameras. The inclinations of orbits of bright meteors are on the average larger than those of faint meteors. The reality of hyperbolic meteor orbits is discussed. Photographic observations of meteors made by the method of instantaneous exposure show that meteors belonging to different showers or associations have respectively different luminosity and fragmentation characteristics. Data about orbital elements of meteors photographed in 1960 to 1963 in Dushanbe and Odessa are presented. Author

N67-32043*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

INFERENCES FROM PHOTOGRAPHIC METEORS

C. C. Dalton *In its* Meteor Orbits and Dust 1967 p 81–90 refs (See N67-32038 18-30)

The masses of a random sample of meteors were recalculated according to the physical theory with rescaled mass. The method followed is outlined and the results are summarized. The spatial weighting factor was used, and is illustrated in graph form. Graphs are also presented for the separate cumulative distributions of radiant celestial latitude over two mass regimes, cumulative distributions of meteoroids, and the logarithms of cumulative terrestrially weighted distributions. N.E.N.

N67-32045*# Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.

METEOR PHOTOGRAPHY WITH AN IMAGE ORTHICON SYSTEM

G. T. Hicks, G. G. Barton, Jr. and W. J. Dambeck *In* NASA, Washington Meteor Orbits and Dust 1967 p 95–103 (See N67-32038 18-30)

The image orthicon camera system is briefly described, and a new method of recording meteors with the system is outlined. Examples of photographs taken with the new electronic shutter technique are included. N.E.N.

N67-32046*# National Research Council of Canada, Ottawa (Ontario).

SOME CHARACTERISTICS OF THE MAJOR METEOR SHOWERS

P. M. Millman *In* NASA, Washington Meteor Orbits and Dust 1967 p 105–108 refs (See N67-32038 18-30)

Twelve physical parameters, found for the major meteor showers, were reduced to simple qualitative indices, which were plotted in relation to the indices for nonshower meteors. The general lack of correlation among these indices suggests a wide spread of physical characteristics within the members of any given meteor shower. Author

N67-32047*# Kiev Univ. (USSR).

RESEARCH ON ORBITS OF MINOR METEOR STREAMS

A. K. Terentjeva *In* NASA, Washington Meteor Orbits and Dust 1967 p 109–114 refs (See N67-32038 18-30)

A detailed analysis of the published data on photographed orbits of individual meteor bodies and visual observations made in the second half of the 19th and first half of the 20th centuries is discussed. Geocentric radiants symmetrically located north and south of the ecliptic were noted and are described. The activity of the minor showers was found to be very complicated and an intricate dynamic problem. Details are given on the hourly, nightly, and seasonal variations of the showers. Distributions of meteors, short-periodic comets, and asteroids are compared, and the similarities are discussed. A connection with comets was found for 12% of the minor streams, and possibilities for the remaining 88% are listed. It is considered that among telescopic and weaker meteors, the fraction organized into meteor streams is much less than among ordinary and bright meteors. N.E.N.

N67-32048*# Slovak Academy of Sciences, Bratislava (Czechoslovakia). Astronomical Inst.

ON TWO PROBLEMS OF SPORADIC METEOR ACTIVITY

J. Stohl *In* NASA, Washington Meteor Orbits and Dust 1967 p 115–117 refs (See N67-32038 18-30)

Seasonal changes of the sporadic radiant distribution are investigated on the basis of Ottawa radar records using a simplified four-source model. The results are compared with the Southern Hemisphere data from Christchurch. Low amplitude and parallel variations of the apex source and of the uniform sporadic background contrast with peculiar changes of the helion and antihelion source; the possible reasons of this effect are discussed. It is shown that the observed absence of geocentric velocities exceeding 73 km/sec does not exclude the existence of some hyperbolic orbits. The comparison of the geocentric velocity distribution in the Northern and Southern Hemispheres is suggested as a potential check of the reality of the hyperbolic component. Author

N67-32049*# Czechoslovak Academy of Sciences, Ondrejov. Astronomical Inst.

REMARK ON A COSMIC-PROBE INVESTIGATION OF METEOR SHOWERS WITH RETROGRADE MOTION

V. Guth *In* NASA, Washington Meteor Orbits and Dust 1967 p 119–120 (See N67-32038 18-30)

It is suggested that a series of probes with slightly different inclinations and launched at different times could measure the dust density function inside the meteor showers. Tentative orbital characteristics are presented for probes which might be launched beginning May 5, 1986, to study showers from Halley's comet. N.E.N.

N67-32050*# Adelaide Univ. (Australia). Dept. of Physics.

INCIDENCE OF METEORS ON THE EARTH DERIVED FROM RADIO OBSERVATIONS

W. G. Elford *In* NASA, Washington Meteor Orbits and Dust 1967 p 121–131 refs (See N67-32038 18-30)

Published estimates of the average flux over the earth of meteors with line densities in excess of prescribed limiting values are compared. The results for sporadic meteors are shown to be consistent within a factor of 2 over the radio magnitude range 0 to +10 and within a factor of 4 between radio magnitude +10 and +13.5. The annual variation in flux is deduced from the precise echo-rate observations made at Ottawa (45°N) and compared with the annual variation determined from a similar survey at Christchurch (43°.5S). The 40 and 50 percent increase in the incidence of meteors during the second half of the year is confirmed. The results of a Southern-Hemisphere orbit survey suggest that this increase is due to a large number of minor showers. For meteors fainter than +5 mag the sporadic flux dominates over any of the major showers, a sporadic/shower ratio of 10:1 being typical for 10th-mag meteors. However, over the range +8 to +12 mag the integrated flux of all shower meteors is about 20 percent of the sporadic flux. The reduction from electron density to mass is still subject to considerable uncertainty. A preliminary

study of 13th-mag meteors suggests that the flux of sporadics with mass greater than 1.3×10^{-8} g is 1.0×10^{-6} $m^{-2}sec^{-1}$. Author

N67-32051*# Lincoln Lab., Mass. Inst. of Tech., Lexington.
RADAR OBSERVATIONS OF METEOR DECELERATION
J. V. Evans *In* NASA. Washington Meteor Orbits and Dust 1967 p 133–149 refs (See N67-32038 18-30)

By means of a narrow-beam high-power radar operating at 68 cm it has been possible to detect meteors traveling radially toward the radar. In these observations the antenna is directed at the radiant point of an intense meteor shower and the receiver tuned to the expected Doppler-shifted signal. Because the actual Doppler shift can be measured with precision, both the velocity and deceleration of the approaching meteor can be determined. The behavior of the velocity is compared with the theory for a solid particle entering the earth's atmosphere at heights where no air cap is formed. Anomalous behavior was observed in several cases, but the height at which this appears to begin is too great to be accounted for by cap formation. We conclude that errors in the computed height of the meteor may be responsible for the anomalous cases. A mean value for the effective ablation energy of 15.4 km^2/sec^2 was obtained, but individual meteors showed wide departures from this value. The mean mass of the meteors is estimated to be in the range 10^{-2} to 10^{-3}g, corresponding to a visual magnitude of +5. Author

N67-32052*# National Research Council of Canada, Ottawa (Ontario).
RADAR METEOR ECHOES
P. M. Millman *In* NASA. Washington Meteor Orbits and Dust 1967 p 151–155 refs (See N67-32038 18-30)
(Contract DA-31-124-ARO(D)-59)

The problems of comparing visual meteor rates with the echo rates recorded by meteor radar equipment are discussed. The uncertainty in the determinations of the magnitude distribution for visual meteors is noted. For most of the visual magnitude range the ratio between numbers in successive whole magnitude groups may be taken as approximately three. Recent studies of the data from the Ottawa radar meteor patrol show marked variations throughout the year in the ratio between the numbers of short- and long-duration echoes. Comparison with the visual data suggests that the ionization in a meteor trail is not proportional to the visual luminosity, and that this relation may vary considerably for different groups of meteors. Preliminary results indicate that visual rates for six observers average 15 to 20 percent higher than the patrol rate for meteor echoes with durations greater than or equal to 1 sec. Author

N67-32053*# Sheffield Univ. (England). Dept. of Physics.
STRUCTURE OF THE MAJOR NORTHERN-HEMISPHERE METEOR STREAMS
L. M. G. Poole *In* NASA. Washington Meteor Orbits and Dust 1967 p 157–169 refs Sponsored by the Sci. Res. Council (See N67-32038 18-30)

Systematic radar observations on the major northern meteor streams have been carried out since 1962 in order to study the variation of the total incident flux and magnitude distribution exponent (s) of shower meteors with solar longitude ($\odot$). Significant gradients in s with $\odot$ have been found for the Perseid, Geminid, and Arietid showers, which are not generally easy to explain in terms of known selective processes acting during the lifetime of the streams. Information has also been obtained concerning the radiant structure of some of the showers. The Perseid radiant is found to consist of a discrete center of activity surrounded by a more diffuse halo. The main Geminid radiant was accompanied in 1962 by a less active radiant that transited an hour earlier than the main one, but which has not since reappeared, and is possibly connected with the periodic Sectanid stream. In 1965 the Quadrantid stream provided a higher meteor rate than any other stream observed, but the high level of activity was maintained over a range of $\odot$ of less than 1°, and appears to be associated with a well-defined radiant. Author

N67-32054*# Lund Observatory (Sweden).
LUMINOSITY FUNCTION OF SPORADIC METEORS AND EXTRAPOLATION OF INFLUX RATE TO MICROMETEORITE REGION
B.-A. Lindblad *In* NASA. Washington Meteor Meteor Orbits and Dust 1967 p 171–180 refs Sponsored by the Swedish Nat. Sci. Res. Council (See N67-32038 18-30)

Data for visual meteors, observed under carefully controlled conditions, are used to determine the luminosity function and mean influx rate of sporadic meteors. The log cumulative distribution curve of absolute meteor magnitudes is studied. It is deduced that the observed number of sporadic meteors increases by a factor of 3.6 per absolute visual magnitude. The mean influx rate of sporadic meteors brighter than or equal to zero absolute magnitude is 0.6×10^{-15} meteors m^{-2} sec^{-1} $(2\pi$ stered$)^{-1}$. Analysis of the visual data shows that the observed ratio of increase r systematically varies with the size of the field of an individual observer. A correction for this effect indicates that the true number of sporadic meteors increases by a factor of 4.3 per absolute visual magnitude. The resulting slope for log cumulative flux versus log mass is −1.28 or −1.58, depending on whether or not the data are weighted as a function of the angular distance of the meteor from the center of field of the observer. Conversion of the observed meteor counts to a mass influx rate and linear extrapolation of the influx data to the micrometeorite region on the basis of the observed r values produce influx rates in good agreement with recent influx data from satellites and space probes. Author

N67-32056*# Sheffield Univ. (England). Dept. of Physics.
DURATION DISTRIBUTION OF RADIO ECHOES OBTAINED FROM UNDERDENSE SHOWER METEOR TRAINS
L. M. G. Poole *In* NASA. Washington Meteor Orbits and Dust 1967 p 181–182 refs (See N67-32038 18-30)

Duration distributions obtained from 17 Mc/sec radar measurements during the activity of the Perseid, Geminid, and Quadrantid meteor showers were compared with theoretical predictions. In each case the r.m.s. deviation of the measured distributions was smaller than expected. Two possibilities are discussed: The distribution in duration distribution may not reflect the true height distribution, and the actual height distribution may not be correctly predicted. It is concluded that: (1) Meteor trains are considerably shorter than predicted by the classical evaporation theory. (2) The geomagnetic field appears to have a noticeable height-dependent effect on diffusion in meteor trains. (3) The classical expression is not adequate. N.E.N.

N67-32058*# Kharkov Polytechnical Inst. (USSR).
RADAR STUDIES OF METEORS
B. L. Kashcheyev and V. N. Lebedinets *In* NASA. Washington Meteor Orbits and Dust 1967 p 183–199 refs (See N67-32038 18-30)

Radar measurements carried out according to the IGY program are presented, and theoretical studies on the physical theory of meteors are discussed. Data analysis on radiants and individual meteor velocities are emphasized. A catalog of meteor streams and associations and tables of radiants and orbits of meteor streams are included. The results are compared with other published data, and were found to be generally in good agreement. The connection of meteor streams with comets and the distribution of orbits of meteor bodies are also discussed. N.E.N.

N67-32057*# National Research Council of Canada, Ottawa (Ontario).
FURTHER DATA CONCERNING THE 1963 ANOMALOUS INCREASE IN RADAR METEOR RATES
B. A. McIntosh *In* NASA, Washington Meteor Orbits and Dust 1967 p 201–202 refs (See N67-32038 18-30)
(Contract DA-31-124-ARO(D)-59)

Data on the increase of radar meteor rates during the middle months of 1963 are presented and are briefly discussed. The possibility that a raising of the height ceiling could explain the restriction of the rate increase to short-duration echoes is mentioned. It is considered that only an unusual increase in atmospheric density in a localized height region could contribute to the increase. N.E.N.

N67-32058*# Hawaii Inst. of Geophysics, Honolulu. Haleakala Observ.
ZODIACAL LIGHT AS AN INDICATOR OF THE NATURE OF THE INTERPLANETARY MATTER—PAST, PRESENT, AND PROSPECTIVE RESULTS
J. L. Weinberg *In* NASA, Washington Meteor Orbits and Dust 1967 p 203–212 refs (See N67-32038 18-30)
(Grant NsG-676)

A brief summary is given of the status of zodiacal light research with emphasis on the interpretation in terms of small solid particles in the solar system. Recent observations are presented which provide further evidence for the existence of large numbers of small dielectric particles as the principal constituents responsible for the observed zodiacal light. Author

N67-32059*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
CONDITIONS OF ENCOUNTER BETWEEN DUST AND THE PLANETS
C. W. McCracken *In its* Meteor Orbits and Dust 1967 p 213–224 refs (See N67-32038 18-30)

The conditions of encounter between interplanetary dust particles and the planets are investigated for the range of particle size where the force of solar radiation is not negligible in comparison with the force of solar gravity. The action of solar-radiation pressure in reducing the heliocentric orbital speed of a small dust particle makes possible very low planetocentric speeds at encounter for an entire class of heliocentric orbits of nonzero eccentricity and fairly low inclination. The speed at encounter and the apparent radiant depend on the size of the dust particle for a given heliocentric orbit throughout the range of particle size investigated by means of dust-particle sensors mounted on spacecraft. Author

N67-32060*# Environmental Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.
THE BRIGHTNESS OF THE ZODIACAL LIGHT AT THE ECLIPTIC POLE
F. E. Roach *In* NASA, Washington Meteor Orbits and Dust 1967 p 225–226 ref (See N67-32038 18-30)

Data on the brightness in the ecliptic and at the pole, and on the ratio of brightness are briefly reviewed. The data are considered to indicate that the ecliptic concentration of the zodiacal light is significant but smaller than generally thought. N.E.N.

N67-32061*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
INTERPLANETARY DUST-PARTICLE FLUX MEASUREMENTS BETWEEN 1.0 AND 1.66 A.U. FROM MARINER 4 COSMIC-DUST EXPERIMENT
W. M. Alexander (Temple Univ.), O. E. Berg, C. W. McCracken, L. Secretan, and J. L. Bohn *In its* Meteor Orbits and Dust 1967 p 227 (See N67-32038 18-30)

Abstracted data on the values of flux and mass distribution of dust particles obtained during the 228-day interval beginning on November 29, 1964, are presented. Among the findings reported are no statistically significant evidence of dust particle streams and no measurable enhancement of the flux in the vicinity of Mars. N.E.N.

N67-32062*# Deutsche Akademie der Wissenschaften zu Berlin (East Germany).
A NEW SOLAR-TERRESTRIAL EFFECT
C. Hoffmeister *In* NASA, Washington Meteor Orbits and Dust 1967 p 229–230 refs (See N67-32038 18-30)

The Arago point was measured and a strong increase of the Arago distance in the evening was found to have a maximum at about $h_{\odot} = -7^{\circ}.8$. A comparison is made to the airglow phenomenon, resulting from the interaction of interplanetary dust particles and the atoms and molecules of the atmosphere. It is concluded that a decrease in dust density explains both the weakness of the increased airglow and the decrease of positive polarization, resulting in large values of Arago point distances. A high mean maximum of Arago distances in 1968 is predicted. N.E.N.

N67-32063*# Academy of Sciences (USSR), Moscow. Inst. of Geochemistry and Analytical Chemistry.
ROCKET AND SATELLITE STUDIES OF METEORIC DUST
T. N. Nazarova *In* NASA, Washington Meteor Orbits and Dust 1967 p 231–237 refs (See N67-32038 18-30)

Data on small meteoric particles obtained in space programs, and calculations and theories based on the data are reviewed. The spacial density and time fluctuations are emphasized. Data from Soviet rockets and satellites are tabulated. Hypotheses explaining the dust cloud around the earth are mentioned, and aggregations of micrometeoric particles not belonging to known meteor streams are described. N.E.N.

N67-32064*# National Aeronautics and Space Administration, Washington, D. C.
RECENT NASA METEOROID PENETRATION RESULTS FROM SATELLITES
C. T. D'Aiutolo, W. H. Kinard, and R. J. Naumann *In its* Meteor Orbits and Dust 1967 p 239–251 refs (See N67-32038 18-30)

The need for direct measurements in the space environment to determine meteoroid penetration rates for application to spacecraft design is discussed. Recent penetration measurements by the Explorer 16 and the Explorer 23 satellites and the Pegasus series of satellites are presented. The primary experiment on the Explorer satellites utilized thin-wall pressurized cells. These cells, covering an aggregate area of about 2 m^2 on each spacecraft, gave indication of meteoroid puncture by loss of internal gas pressure. Each of the large-winged Pegasus satellites measured meteoroid penetrations over a surface area of more than 200 m^2 by means of electrical capacitor-type detectors that discharge when penetrated. The large detector area on these spacecraft permitted the use of target materials up to 0.040 cm in thickness. The penetration statistics obtained to date from the satellites are presented and compared with estimates of expected penetration rates. The satellite measurements appear to have reduced significantly the uncertainty in predicting the penetration frequency in materials approaching actual spacecraft-skin thicknesses. Further measurements are required, however, before an accurate mass–frequency distribution of penetrating meteoroids can be established. Author

N67-32065*# Manchester Univ. (England). Physics Lab.
SOME PENETRATION AND CHARGE-DETECTION TECHNIQUES
R. C. Jennison *In* NASA, Washington Meteor Orbits and Dust 1967 p 253–257 refs (See N67-32038 18-30)

The instrumentation and detection techniques used on Skylark rockets and the Ariel 2 satellite for investigating dust particles in

space are described. Details are given on the instantaneous-read-out detectors and the delayed-read-out detectors used on the Ariel 2 satellite. Preliminary results of data analysis indicate that the particle density is small and the radiation pressure limit is higher than was estimated earlier. An electrostatic charge detection technique is described for observing micrometeorites greater than 3 microns in diameter. N.E.N.

N67-32066*# National Aeronautics and Space Administration, Washington, D. C.

DIRECT MEASUREMENTS OF THE MASS DISTRIBUTION AND TIME VARIATIONS IN THE FLUX OF SMALL DUST PARTICLES

W. M. Alexander (Temple Univ.), C. W. McCracken, and M. Dubin *In its* Meteor Orbits and Dust 1967 p 259–270 refs (See N67-32038 18-30)

Information concerning the mass distribution and the time variations in the flux of small dust particles has been obtained with dust-particle sensors flown outside the atmosphere of the earth. The relevant data have been obtained primarily with the microphone type of dust-particle sensor flown on near-earth satellites. These measurements are in good agreement with the mass distribution measured with the microphone system on Explorer 8. The measured flux of dust particles often shows temporal variations of a factor of 10 within intervals of several hours, as well as larger, systematic enhancements of flux or sporadic showers which persist for intervals ranging from several hours to a few days. Author

N67-32067*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

PHYSICAL PARAMETERS OF COSMIC DUST OBTAINED FROM ROCKET COLLECTIONS

O. E. Berg and L. Secretan *In its* Meteor Orbits and Dust 1967 p 271–284 refs (See N67-32038 18-30)

The instruments and techniques used on the Aerobee rocket to measure and record the parameters of the earth's cosmic dust environment are described. Glass cylinders were optically polished and coated with an opaque layer of evaporated metal 2500 Å in thickness. All cylinders were scanned twice before flight as well as after for pinholes or similar surface transparencies. Photographs are presented of cosmic dust impact craters, and a discussion of the photographs is included. It was concluded that: (1) Cosmic dust encompasses a wide range of particle densities, shapes, sizes, and velocities. (2) Penetration parameters for low density, hypervelocity microparticles vary widely from laboratory-based predictions. (3) Surface damage rather than penetration presents the greater hazard to space material. N.E.N.

N67-32068*# Douglas Aircraft Co., Inc., Santa Monica, Calif. Space Sciences Dept.

ELECTRON DIFFRACTION CONTROL STUDIES OF VENUS FLYTRAP PARTICLES

N. N. Greenman and C. B. Gilpin *In* NASA, Washington Meteor Orbits and Dust 1967 p 285–291 refs (See N67-32038 18-30)

A study was undertaken to investigate whether possible extraterrestrial particles collected by the Venus Flytrap rocket could suffer cosmic radiation damage, and the control study on olivine and enstatite is reported. Finely powdered samples were collected on a carbon substrate and diffraction patterns obtained are presented. It was determined that the conditions under which the patterns could be obtained were: (1) The substrate must be thin. (2) Observation and photographic recording must be made rapidly before the buildup of contamination due to electron beam decomposition of vacuum system hydrocarbons. (3) A tilting stage should be used to allow the most favorable crystallographic orientation to be selected. It is concluded that the first two conditions can be readily achieved, and ways of circumventing the third are mentioned. N.E.N.

N67-32070*# Smithsonian Astrophysical Observatory, Cambridge, Mass.

MEASURED VELOCITIES OF INTERPLANETARY DUST PARTICLES FROM OGO-1

C. S. Nilsson and W. M. Alexander (Temple Univ.) *In* NASA, Washington Meteor Orbits and Dust 1967 p 301–305 refs Sponsored by NASA and NAS (See N67-32038 18-30)

Details are given on the instrumentation, the impact parameter data, and the probable orbits of three particles. The method of calculating the orbital elements is discussed, and probability distributions are shown for orbital inclinations and eccentricities. It is suggested that the particles were in heliocentric orbits. N.E.N.

N67-32071*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

MEASUREMENTS OF INTERPLANETARY DUST-PARTICLE FLUX FROM EXPLORER 16 CdS AND WIRE GRID DUST-PARTICLE DETECTORS

L. Secretan *In its* Meteor Orbits and Dust 1967 p 307–315 refs (See N67-32038 18-30)

The CdS dust-particle detectors on Explorer 16 provide a means of determining the flux of dust particles in the vicinity of the earth by measuring the area of the perforations due to impacts of dust particles $\geq 10^{-10}$g through a 1/4-mil aluminized mylar film. One of the CdS detectors measured a total area of 0.08 mm^2 perforated by dust particles for a period of 55 days. (The other measured an area of 0.068 mm^2 in 19 days.) The perforated area is proportional to the cumulative flux of all impacting particles $\geq 10^{-10}$ g. The flux measured by the detectors is compared with several models provided by other satellite and various ground-based observations. When the flux model derived from the direct satellite measurements is used, where log $I = -17.0 - 1.7$ log M, it is found that approximately 10^3 impacts would occur. The area opened up by these impacts is in excellent agreement with the results of the CdS detector experiment. Flux models derived from ground-based observations predict too few impacts for the mass range of particles considered here. The wire grid experiment would detect particles of 10^{-7} g and larger. Two wires were broken. This is in good agreement with the dust-particle flux model derived from direct satellite measurements. Author

N67-32072*# Miami Univ., Coral Gables, Fla.

DUST DYNAMICS IN THE MAGNETOSPHERE AND INTERPLANETARY SPACE

S. F. Singer *In* NASA, Washington Meteor Orbits and Dust 1967 p 317–322 refs (See N67-32038 18-30) (Grant NGR-10-007-011)

The major forces acting on dust particles near the earth or in interplanetary space are produced by gravitational fields. For very small bodies of micron or submicron size, however, we must take into account minor forces, such as radiation pressure, Coulomb drag, and the Lorentz force. These minor forces can produce significant effects on dust particles near the earth, e.g., an evening–morning asymmetry in dust impacts. They also affect the distribution and lifetime of dust in interplanetary space. Author

N67-32074*# Naval Research Lab., Washington, D. C. E. O. Hulburt Center for Space Research.

PHOTOGRAPHS OF PARTICLES FROM AN AEROBEE ROCKET AT 130-km TO 204-km ALTITUDE

R. Tousey, M. J. Koomen, R. E. McCullough, and R. T. Seal *In* NASA, Washington Meteor Orbits and Dust 1967 p 333–344 refs Sponsored by NASA (See N67-32038 18-30)

Photographs were obtained of the solar corona from 1° to 2°.5 from the sun's center, at altitudes from 131 km to 204 km, by means of an externally occulted Lyot coronagraph flown in Aerobee-150 rocket on June 28, 1963. They show many tracks produced by particles, shining brightly by sunlight scattered forward at a small angle. Analysis of the trails indicates that the particle diameters were 10 to 30 μ. Distances from the rocket ranged

from 1 to 500 feet or more. The velocities relative to the rocket were 0.1 to 1.5 m/sec. This is not surprising, because particles with greater relative velocities would not have been detected photographically. It is difficult to explain the behavior of the distant particles on the assumption that they came from the rocket. It is proposed that some are natural particles, of meteoritic origin. Author

N67-32075*# Minnesota Univ., Minneapolis. School of Physics and Astronomy.
VERTICAL DISTRIBUTION OF DUST IN THE STRATOSPHERE
J. M. Rosen and E. P. Ney *In* NASA, Washington Meteor Orbits and Dust 1967 p 345–347 refs (See N67-32038 18-30)
(Contract Nonr-710(22))

The balloon-borne photoelectric particle counter is briefly described, and graphs of dust concentrations are presented and are discussed. It is pointed out that if the mixing ratio of dust and air in the stratosphere is constant in a given region, then the source is above that region. It is concluded that the stratospheric dust observed on the balloon flights was above 27 km, and it is further concluded that it is of meteoritic origin. N.E.N.

N67-32076*# High Altitude Observatory, Boulder, Colo.
METEORIC DUST IN THE STRATOSPHERE DETERMINED BY OPTICAL SCATTERING TECHNIQUES
G. Newkirk, Jr. *In* NASA, Washington Meteor Orbits and Dust 1967 p 349–358 refs (See N67-32038 18-30)
(Contract Nonr-393(05))

Observations of the sky radiance variations with height are compared with what would be expected if the sky radiances were measured in a pure, molecular atmosphere with three different models. Both observed and calculated scattering values include the effects of the solar zenith distance variations during flight. The equation for the transfer of radiation through a turbid atmosphere is solved, and the size distributions with respect to height are obtained. A previous conclusion that a predominantly terrestrial aerosol layer exists at a height of approximately 20 km is thought to be confirmed. A steady state and diffusion and sedimentation mechanism are assumed for regulating the flow of particles, and meteoric influx rates are discussed. It is considered that the storage of meteoric debris for long periods of time effectively smooth out the influx variations. It is also concluded that a proposed geocentric condensation of interplanetary dust does exist. N.E.N.

N67-32077*# Lincoln Lab., Mass. Inst. of Tech., Lexington.
DYNAMICS OF ORBITING DUST PARTICLES
I. I. Shapiro, D. A. Lautman, and G. Colombo (Smithsonian Astrophys. Obs.) *In* NASA, Washington Meteor Orbits and Dust 1967 p 359 ref (See N67-32038 18-30)

Abstracted data on forces affecting interplanetary dust motion and the factors contributing to the concentration of dust around the earth are presented. Results indicate a flux increase of about a factor of 100 over the interplanetary value for a velocity of 1 km/sec, or less than a 10 for a velocity of 3 km/sec. N.E.N.

N67-32079*# Alaska Univ., College. Geophysical Inst.
ROLE OF METEORIC DUST IN THE LOWER IONOSPHERE
R. Parthasarathy and D. B. Rai *In* NASA, Washington Meteor Orbits and Dust 1967 p 365 ref (See N67-32038 18-30)

Results of an investigation on the effect of the meteoric dust particles on the steady state distribution of electrons and ions in the lower ionosphere are abstracted. The recombination coefficients were computed and found to be in good agreement with those deduced empirically. It is concluded that the influence of the dust in the ionosphere is significant. N.E.N.

N67-32080*# Harvard Coll. Observatory, Cambridge, Mass.
INFRARED OPTICAL CHARACTERISTICS OF ICE SPHERES
W. M. Irvine *In* NASA, Washington Meteor Orbits and Dust 1967 p 367–372 refs (See N67-32038 18-30)
(Grant NsG-89-60)

Calculations of the scattering and absorption properties of ice particles were made using the Mie theory. The values of the normalized extinction cross section, the single-scattering albedo, and the asymmetry factor were obtained for spherical, homogeneous particles of radii 1.0, 4.0, 7.5, 10.0, 12.5, and 15.0 microns for the wavelength interval 1 to 150 microns. Graphs are presented of the results. The data indicate the possibility of using absorption spectra to determine approximate particle size in reflection from ice clouds and of differentiating between water and ice clouds in planetary atmospheres. N.E.N.

N67-32081*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
EVIDENCE FOR EXTRATERRESTRIAL PARTICLES IN POLAR ICE
E. L. Fireman *In* NASA, Washington Meteor Orbits and Dust 1967 p 373–380 refs (See N67-32038 18-30)

Sufficiently large samples of Greenland dust were collected so that isotope analysis could be made. There were definite positive indications of Fe^{60} and excess Ar^{36} and a less definite positive indication of excess He^3. The Fe^{60} can be explained by solar-flare interactions on iron and nickel; and Ar^{38} and He^3 excesses can be explained by solar-flare implantation. There was no positive indication of Al^{26}, indicating that the magnesium–aluminum–silicon extraterrestrial constituents were dissolved. Author

N67-32082*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
ON CHEMICAL COMPOSITIONS OF INTERIORS OF POSSIBLY COSMIC PARTICLES AND THE PROBLEMS OF ORIGIN OF NATURALLY OCCURRING IRON-RICH SPHERULES
P. W. Hodge and F. W. Wright *In* NASA, Washington Meteor Orbits and Dust 1967 p 381–387 refs (See N67-32038 18-30)

The chemical and physical characteristics of iron-rich spherules of known and unknown origin are reviewed. Data on spherules found at meteorite craters, volcanoes, and those artificially produced are described, and are summarized in tabular form. It is concluded that on the basis of the nickel content, a large fraction of the spherules from deep sea and lake bed sediments are from iron meteorites. Since the relative abundances of iron, aluminum, silicon, calcium, and titanium are characteristic of volcanic spherules, it is concluded that roughly 5% of ice cap spherules are volcanic, and that the percentage is higher in areas where volcanoes have recently erupted. The majority of spherules were found not to have a composition similar to those of known origin, and it is suggested that they are ablation products from cometary meteors. N.E.N.

N67-32083*# Brown Univ., Providence, R. I. Dept. of Geology.
RECOVERY OF MAGNETITE SPHERULES FROM SEDIMENTARY ROCKS
T. A. Mutch and J. T. Parr *In* NASA, Washington Meteor Orbits and Dust 1967 p 389 (See N67-32038 18-30)

The difficulties involved in separating magnetite spherules from sedimentary rocks are briefly reviewed. Disaggregation of the rock by solution in HF and by magnetic separation are mentioned. It is emphasized that caution must be used in interpreting results, and especially results on influx rates of the past as compared with those of the present. N.E.N.

N67-32084*# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
FUSION CRUST OF IRON METEORITES AND MESOSIDERITES AND PRODUCTION OF COSMIC SPHERULES
A. El Goresy and H. Fechtig *In* NASA. Washington Meteor Orbits and Dust 1967 p 391–397 refs (See N67-32038 18-30)

Detailed mineralogical and microprobe studies were carried out on the fusion crusts of the Sikhote–Alin and Pinaroo meteorites. The fusion crusts are about 1.5 mm thick and are composed of complex metal and iron oxide layers. The innermost layer is relatively thin and is composed mainly of recrystallized metal, followed by a magnetite metal layer. Magnetite shows skeletal crystals, droplets, and stalactitic textures typical of crystals separating from a melt by fast cooling. Magnetite is partially intercalated by nickel–iron spherules. In the outermost layer some nickel–iron spherules were observed, as well as a thin sheet of wustite. Some of these spherules show eutectic intergrowth between nickel–iron and schreibersite. Microprobe measurements of the spherules, the magnetite zone, and the border between the magnetite and the unaltered meteorite were carried out for nickel, iron, and cobalt. The results show an enrichment of the nickel in these spherules and in the outer part of the nonoxidized meteoritic material. The results strongly support the theory of the production of the cosmic spherules by ablation as far as they consist of magnetite.
Author

N67-32085*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SOME STUDIES OF SEPARATED FRACTIONS OF LOW ACCUMULATION-RATE "DUST"
D. Tilles *In* NASA. Washington Meteor Orbits and Dust 1967 p 399–412 refs (See N67-32038 18-30)
(Grant NSF G-16067)

Anomalous isotope ratios were found in argon released at 1200°C from magnetically separated fractions of a Pacific red clay sea sediment and from a density separated fraction of Greenland dust. The minimum values of Ar^{40}/Ar^{36} found in the sea sediment were 196±6 and 194±10 and in the Greenland material 230±5. Ratios of Ar^{36}/Ar^{38} were consistent with air ratios, with a value of 5.21±0.08 for the Greenland temperature fraction containing the greatest amount of anomalous argon. Amounts of excess Ar^{36}, relative to air, varied from 5 to 10×10^{-10} cm^3 STP g^{-1}. The measurements confirm earlier argon results on the Pacific red clay, and extend them to material from Greenland, demonstrating that the argon anomalies are a worldwide phenomenon. No evidence of cosmic-ray or solar-flare-produced spallation argon nor of solar-wind or solar-flare-imbedded He^3 was observed. X-ray studies indicate that the one mineral detectable in both Pacific and Greenland anomaly-bearing samples is magnetite. Arguments against a terrestrial origin for the argon anomalies are presented, and possible extraterrestrial mechanisms that might account for them are reviewed.
Author

N67-32186# European Space Technology Center, Delft (Netherlands).
THE METEORITE ENVIRONMENT OF EARTH SATELLITES
S. L. Entres *In its* Spacecraft Technol. Vol. V Dec. 1966 12 p refs *Its* Lecture No. 44 (See N67-32181 18-31)

The general properties of meteorites from environmental assessment and laboratory investigations are reviewed, emphasizing the impact hazard to spacecraft. Meteoric flux distributions are considered, and expressions are divided to describe the meteoritic environment of earth satellites. Studies on the penetration power of particles with velocities up to 5 km/sec are summarized, and the Poisson distribution is applied to the likelihood of meteorite impacts. The lack of accurate data and the necessary caution needed in using available information are stressed throughout. It is felt, however, that the data presented should assist in the estimation of meteorite hazards.
N.E.N.

N67-32257# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SPACE PROGRAMS SUMMARY NO. 37-45, VOLUME VI FOR THE PERIOD MARCH 1, 1967 TO APRIL 30, 1967. SPACE EXPLORATION PROGRAMS AND SPACE SCIENCES
31 May 1967 31 p refs
(Contract NAS7-100)
(NASA-CR-86607; JPL-SPS-37-45; Vol. VI) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Summarized are research conducted under the Lunar Program; the Planetary-Interplanetary Program; and the Deep Space Network Program. Cited are quality assurance and reliability efforts; environmental- and dynamic testing facility-development activities; and a reprint of the space science instrumentation studies of the Lunar Program and the Planetary-Interplanetary Program.
S.C.W.

N67-32308*# Volt Technical Corp., Washington, D. C.
SOMETHING NEW ABOUT VENUS [NOVOYE O VENERE]
D. Martynov 22 Jun. 1967 4 p Transl. into ENGLISH from Pravda (Moscow), no. 165, 1967
(Contract NAS5-12487)
(NASA-CR-86635; ST-PR-LPS-10628) CFSTI: HC $3.00/MF $0.65 CSCL 22A

A general discussion of the planet Venus is presented in terms of atmosphere, temperature measurements, cloud cover, and length of day. Implications of the high temperatures of Venus are noted; and mention is made of the Soviet cosmic rocket, Venus-4, launched June 12, 1967.
M.W.R.

N67-32311* Volt Technical Corp., Washington, D. C.
CHRONOLOGICAL ABSTRACT LISTING, RUSSIAN–FRENCH, SCIENTIFIC LITERATURE Second Quarter, 1967
Andre L. Brichant 1967 15 p refs
(Contract NAS5-12487)
(NASA-CR-86652) CFSTI: HC $3.00 CSCL 20H

Abstracts are presented for 48 articles on space-related subjects that were translated from the open Soviet literature of 1966 and 1967. Titles, authors, and sources are given for each entry; and the listing is presented in chronological order.
M.W.R.

N67-32318*# California Univ., Berkeley. Space Science Lab.
INTERPLANETARY SECTOR STRUCTURE, 1962–1966
Norman F. Ness (NASA. Goddard Space Flight Center) and John M. Wilcox 4 May 1967 20 p refs *Its* Ser. No. 8, Issue No. 40
(Grant NsG-243; Contract Nonr-3656(28))
(NASA-CR-86947) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Some properties of the interplanetary magnetic field observed by IMP-3 in the latter half of 1965 are discussed with relation to previous satellite observations of the interplanetary field. The sector property remains a prominent feature of the observations, with the average field direction at the Archimedes spiral angle. The sector pattern has a 27-day recurrence period from 1962 to 1964, and during the year 1964 the pattern appears to be quasi-stable. In 1965 the recurrence period is about 28 days, and the evolution of the pattern is more rapid, with new sectors appearing and expanding.
Author

N67-32320*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FUNCTIONAL DESIGN OF THE MARINER MIDCOURSE MANEUVER OPERATIONS PROGRAM
H. J. Gordon 15 Jul. 1967 42 p refs
(Contract NAS7-100)
(NASA-CR-86914; JPL-TR-32-1139) CFSTI: HC $3.00/MF $0.65 CSCL 22C

This document specifies the functions of the Mariner midcourse maneuver operations program. The program has two functions: (1) establish the existence of maneuvers satisfying spacecraft constraints, and (2) compute these maneuvers and code them into commands acceptable to the spacecraft. Besides the decision programs that must be used if the flight goes according to plan, the program is capable of exploring alternate trajectories if some out-of-tolerance condition forces a change in plans. A discussion of the engineering and operational considerations governing the design of the program is given, as well as the derivation of most of the less obvious equations. Author

N67-32328# California Inst. of Tech., Pasadena. Owens Valley Radio Observatory.
THE EAST-WEST STRUCTURE OF RADIO SOURCES AT 1425 MHz
E. B. Fomalont 1967 79 p refs Submitted for publication
(Contract N00014-67-A-0094-0008)
(Rept.-7; AD-653261) CFSTI: HC $3.00/MF $0.65

The east-west brightness distribution of over 500 radio sources, 200 of them resolved, are given in tabular and graphical form. The observations were taken with the Caltech twin-element interferometer at a frequency of 1425 MHz. Nine separations from 144 wavelengths to 2626 wavelengths were used to synthesize an east-west fan beam of 45 seconds of arc. TAB

N67-32343# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
ANNUAL REPORT (1965–1966) OF THE COSMOCHEMISTRY DIVISION [JAHRESBERICHT 1965–66 DER ABTEILUNG KOSMOCHEMIE]
In its Nucl. Phys. Work 1966 p 119–158 refs (See N67-32341 18-24)

Progress is reported in a number of meteorite and tektite studies covering isotope composition, age determination, diffusion of elements, and radioactive intensities. The K–Ar method, the fission track method, chemical analyses, and examination of spherules were used for age determinations and to establish the genetic connection between tektites and meteorite craters. Age and rare gas isotope measurements were also made on some terrestrial rock samples. In space research, the investigations covered cosmic dust and cosmic radiation, participation in NASA's Luster program, and mass spectrometry of the upper atmosphere. Activities of the Freiburg station in the monitoring of cosmic ultra radiation and radioactive aerosol in the atmosphere are summarized. Transl. by K.W.

N67-32360# Air Force Cambridge Research Labs., Bedford, Mass. Space Physics Lab.
GEOPHYSICS AND SPACE DATA BULLETIN, VOLUME III, NO. 4, FOURTH QUARTER 1966
Anne L. Carrigan and Norman J. Oliver, ed. [1967] 174 p
(AD-650274) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. TOTAL FIELD INTENSITY MAGNETOMETER p 3–14
2. COSMIC RAY NEUTRON INTENSITY MONITOR p 15–31
3. OBLIQUE HIGH-FREQUENCY PROPAGATION p 33–36
4. RIOMETER p 37–39
5. SOLAR OPTICAL PATROL OBSERVATIONS p 41–89
6. SOLAR RADIO EMISSION p 91–122
7. VERTICAL INCIDENCE IONOSPHERIC SOUNDINGS p 123–176

N67-32372*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE USE OF RESONANT LIBRATING ORBITS IN SATELLITE GEODESY
C. A. Wagner Washington, NASA, Aug. 1967 30 p refs
(NASA-TN-D-4081) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A satellite for which the orbital rate is commensurate with the earth's rotation rate will describe a constant ground-track over a whole number of sidereal days. On such a satellite, the small orbit-averaged, along-track force from certain longitude harmonics of gravity can build up over many commensurate periods to produce appreciable changes in the semimajor axis of the orbit and longitude placement of the ground-track. The libratory nature of these changes and the specific harmonics which can cause them for any resonance case are discussed with reference to a circular orbit. General formulas are presented for these librations, with typical errors determined by numerical integration. Actual orbit data from three 24 hour satellites are used in connection with these formulas to determine the resonant earth gravity sectorial harmonics through third order. These are found to be $10^6\ \bar{C}_{22} = 2.42 \pm 0.03$, $10^6\ \bar{S}_{22} = 1.44 \pm 0.03$, $10^6\ \bar{C}_{33} = 0.32 \pm 0.11$, and $10^6\ \bar{S}_{33} = 1.18 \pm 0.11$. It is shown that a number of subsynchronous circular resonant orbits offer similar promise in easily and uniquely discriminating other low and high-order longitude Harmonics, including H_{32}, H_{43}, H_{54}, H_{65}, H_{76}, and H_{88}. Author

N67-32376*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
SOLAR ELECTRIC SPACE MISSION ANALYSIS Progress Report, 1 Jan.–31 Mar. 1967
P. M. Lion 15 Jul. 1967 23 p
(Contract NSR-31-001-078)
(NASA-CR-86917) CSCL 22C

A two-dimensional heliocentric optimization program that selects the thrusting program and propulsion parameters in order to maximize payload for a given space mission is described. Additions to the program included subroutines that give launch vehicle, ion engine, and solar array performances. An ephemeris routine was added which computes the initial and final conditions used in the iteration, given the Julian launch data and trip time. Addition of sweep capability for several parameters and options that allow propulsion parameters to be held fixed or optimized is also discussed. Changes to increase flexibility and efficiency are cited. The main effort in solar electric mission analysis was the study of the Jupiter flyby mission. Figures are presented to illustrate the three modes identified over the range of flight times studied. S.P.

N67-32377*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VENUS: PRELIMINARY SCIENCE OBJECTIVES AND EXPERIMENTS FOR USE IN ADVANCED MISSION STUDIES
Roy G. Brereton, Frank T. Barath, Walter E. Brown, Richard W. Davies, Charles E. Giffin et al 1 Aug. 1966 29 p refs Revision 1
(Contract NAS7-100)
(NASA-CR-86667; JPL-TM-33-282, Rev. 1) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This document reviews current knowledge about the planet Venus and describes several scientific objectives and supporting experiments for a 1500-lb Mariner-type spacecraft to be flown to the planet in the early 1970's. A combination flyby/capsule mission appears to best satisfy the scientific requirements for the mission. Author

N67-32390*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME III: INSTRUMENTATION STUDY Final Report
A. R. Barger and J. F. Baxter [1967] 184 p refs
(Contract NAS1-6607)
(NASA-CR-66406) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Present knowledge of Venus is appraised and the general scientific objectives of an early Venus mission are defined. More specific objectives or measurements are given and priorities assigned. Experiments relating to these objectives, which are

compatible with the buoyant Venus station concept are examined and arranged into payloads for a 200- and 2000-lb BVS. Detailed characteristics of experiments, drop sonde configurations, atmospheric circulation pattern, possible BVS missions and trajectories, and tracking instrumentation are discussed in appendixes. Author

N67-32463# RAND Corp., Santa Monica, Calif.
CHANDRASEKHAR'S PLANETARY PROBLEM WITH INTERNAL SOURCES
R. Bellman, H. Kagiwada, R. Kalaba, and S. Ueno May 1967 24 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5229-PR; AD-652832) CFSTI: HC $3.00/MF $0.65

Invariant imbedding equations are developed for the determination of the vertical stratification of terrestrial and other planetary atmospheres on the basis of satellite observations. The top altitude of a cloud, for example, can be estimated from the relative spectral intensities of the solar radiation reflected from the cloud in the oxygen A band at 7600 angstrom, and in a nearby window. The results of RM-5245-PR are extended to solve the Chandrasekhar planetary problem for atmospheres with or without internal energy sources, and with or without bottom surface reflectivity, either Lambert or nonorthotropic. The differential-integral equations may be approximated by systems of stable initial-value problems that are readily and accurately solved by digital computers. TAB

N67-32484*# RAND Corp., Santa Monica, Calif.
SOME ASPECTS OF THE CIRCULATION OF MARS
Conway Leovy Nov. 1965 27 p refs Presented at Conf. on Exploration of the Planets, Blacksburg, Va., 16–20 Aug. 1965
(Contract NASr-21(07))
(NASA-CR-86912; P-3262) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Estimates of the vertical temperature structure and heat balance of Mars are reviewed and compared with the corresponding quantities on the Earth. The probable resulting circulation is discussed, and reasons for expecting a stronger solstice circulation on Mars than on the Earth are given. The problem of thermally driven tides is reviewed. The amplitude of such tides is likely to be small. Author

N67-32509*# Volt Technical Corp., Washington, D. C.
ON THE POSSIBILITY OF REFINING BY MEANS OF OPTICAL LOCATION SOME ASTRONOMICAL PARAMETERS OF THE SYSTEM: EARTH–MOON
Yu. L. Kokurin, V. V. Kubasov, V. F. Lobanov, A. N. Sukhanovskiy, and N. S. Chernykh 22 Jun. 1967 9 p ref Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 2, 1967 p 219–224
(Contract NAS5-12487)
(NASA-CR-86680; ST-CM-OA-LPS-10627) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A mathematical treatment is performed of the possibilities of determining by the results of optical location of the moon the following parameters, using an artificial light reflector on its surface: the mean radius and the eccentricity of the lunar orbit; the selenographic coordinates of the point being located, i.e., the latitude, longitude and the radius-vector of moon's relative mass center; the radius-vector of the point of observation relative to the mass center of the earth; and the ephemeris time. Analysis of the possible errors is conducted and it is shown that the precision of determination of these parameters may be significantly higher than the precision with which they are known, or may be determined by other methods. However, the attaining of high precision is possible only on the condition of preliminary investigation of physical libration, of which the insufficient knowledge of laws may lead at the present time to great errors in the parameters investigated. The possibility is indicated of libration measurement by the method of optical location. Author

N67-32672*# LTV Aerospace Corp., Dallas, Tex. Missiles and Space Div.
DEFINITION OF EXPERIMENT PROGRAM IN SPACE OPERATIONS, TECHNIQUES AND SUBSYSTEMS. ADDENDIUM I: DESIGN, BREADBOARD AND TESTING OF AN EXPERIMENTAL GRAPPLING MANIPULATOR AND CONTROLLER Final Report
Jul. 1967 106 p refs
(Contract NAS8-21024)
(NASA-CR-86676; Rept.-00-960; Addend. 1) CSCL 20A

Progress is reported on a simplified electromechanical docking and anchoring manipulator employing astronaut rate and acceleration commands to position the six-degrees-of-freedom manipulator arm, as well as to control the opening of the attachment tongs. Design, breadboard, and testing of an experimental grappling manipulator and controller is reported. Two devices were studied: the maneuvering work platform (MWP) and the space taxi. The MWP is an early availability concept consisting of an open structure, which is operated by a pressure-suited astronaut. This concept is essentially a maneuverable workshop with self contained power, propulsion, attitude stabilization, and environmental control/life support system. It carries a full complement of tools and spare parts for orbital servicing and maintaining of other vehicles. The space taxi features environmentally controlled encapsulation of the astronaut. It provides the capability of performing maintenance tasks in a shirt-sleeve environment by means of bilateral master-slave manipulators controlled from within the pressurized cabin. S.P.

N67-32677# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
APPLICATION OF THE GRADIENT METHOD TO THE NUMERICAL STUDY OF LIMITED-POWER TRANSFERS BETWEEN NEAR-COPLANAR CIRCULAR ORBITS. COMPARISON WITH THE LINEARIZED SOLUTION [APPLICATION DE LA METHODE DU GRADIENT A L'ETUDE NUMERIQUE DES TRANSFERTS A PUISSANCE LIMITEE ENTRE ORBITES CIRCULAIRES COPLANAIRES PROCHES. COMPARAISON AVEC LA SOLUTION LINEARISEE]
Herve Girard (M.S. Thesis) 1967 91 p refs In FRENCH; ENGLISH summary
(ONERA-TN-112(1967)) CFSTI: HC $3.00/MF $0.65

By means of a numerical method, the optimum trajectories for orbital transfers between coplanar circular orbits having nearly the same radius and for power-limited propulsion systems whose ejection velocity may vary are determined. The results are compared to those given by a linearized analytical calculation. Using the gradient method, which has been retained following an examination of the various applicable methods of optimization, for the various radius ratios close to unity, the transfer trajectories with and without rendezvous and also the corresponding consumption are obtained. An examination of these results leads to an evaluation of the validity of the hypothesis of linearization around the initial orbit as a function of the radius ratio. Author

N67-32588*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR SURFACE MECHANICAL PROPERTIES
E. M. Christensen, S. A. Batterson, H. E. Benson, R. Choate, L. D. Jaffe, et al *In its* Surveyor III, A Prelim. Rept. Jun. 1967 p 94–120 refs (See N67-32582 18-31)

Mechanical properties of the lunar surface at the Surveyor III landing site appeared to be similar to those at the Surveyor I site. Lunar soil static bearing capability was determined as 2×10^5 to 5.5×10^5 dynes/cm^2 for a penetration depth of 2.5 to 5 cm and for an area equivalent to that of a footpad. Footpad imprint

simulations suggested that the lunar surface material contains substantial amounts of particles finer than sand grains. Imprints and soil throwout patterns indicated a low compressibility of the lunar surface material. An upper bound for lunar soil cohesion was determined from the bearing strength as less than 1.4×10^5 dynes/cm^2 at a depth of about 20 cm. Spacecraft oscillations following the landing projected a rigidity modulus and shear wave velocity lower than those for loose terrestrial sand. G.G.

N67-32586*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR TEMPERATURES AND THERMAL CHARACTERISTICS
J. W. Lucas, J. E. Conel, W. A. Hagemeyer, C. B. Jones, J. M. Saari *et al* *In its* Surveyor III. A Prelim. Rept. Jun. 1967 p 121–137 refs (See N67-32582 18-31)

Outer canister temperatures of two electronic compartments on Surveyor III were used to estimate the average brightness temperature of those portions of the lunar surface viewed by the compartments. Observed lunar surface temperatures were in good agreement with predicted values around noon and comparable to a homogeneous surface model with thermal inertia greater than 400. During the afternoon, compartment temperatures were somewhat higher than expected from Earth-based data. Both compartments saw the same lunar surface temperature throughout all the the umbral and almost all of both penumbral phases; this indicated nondirectional lunar surface emission at low insulation. G.G.

N67-32587*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR SURFACE ELECTRICAL PROPERTIES
W. E. Brown, R. A. Dibos, G. B. Gibson, D. O. Muhleman, W. H. Peake *et al* *In its* Surveyor III A Prelim. Rept. Jun. 1967 p 139 (See N67-32582 18-31)

Radar (radar altimeter and doppler velocity sensor) preliminary results for Surveyor III indicate that the radar cross section (rxs) for the 25° off-nominal and vertical beams were approximately the same as those obtained from the Surveyor I data and Earth-based measurements. The rxs values of −12 db for the 25° beams for regions external to the crater in which the spacecraft landed and −8 to −4 db for the vertical beam yield an estimate of the relative dielectric constant as $\epsilon = 3.7 + 0.5/-1.0$. These measurements and estimates coupled with Earth-based measurements of the factors of microwave phase lag angle (40°), thermal parameter (1420), and specific heat (0.2) allow a value for the ratio of the electrical loss tangent to density to be computed as $\tan \phi/\rho = 2.57 \times 10^{-2} \pm 20\%$ Author

N67-32588*# National Aeronautics and Space Administration, Washington, D. C.
LUNAR THEORY AND PROCESSES
D. Gault, R. Collins, T. Gold, J. Green, G. P. Kuiper *et al* *In its* Surveyor III. A Prelim. Rept. Jun. 1967 p 141–156 refs (See N67-32582 18-31)

Preliminary evaluation of Surveyor mission information gained data on physical and mechanical properties of the surficial layer of the lunar surface from the soil surface sampler and from an unprogrammed multiple landing sequence. An absence of adhesion forces was established through the clean operation of the soil sampler. Surveyor pictures of strewn rock formations indicated rounded shapes and downhill movement of the fine material of the lunar surface layer. The dielectric constant for the observed lunar surface corresponded to known values of clear silica glass, namely 3.8. G.G.

N67-32630*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
VENUS: PRELIMINARY SCIENCE OBJECTIVES AND EXPERIMENTS FOR USE IN ADVANCED MISSION STUDIES
Roy G. Brereton 22 Dec. 1965 57 p
(Contract NAS7-100)
(NASA-CR-75609; EPD-328) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Scientific objectives and supporting experiments are described for proposed Marine-type spacecraft missions to the planet Venus in the 1970's. Consideration is given to flyby and capsule missions, and a combination of the two is thought to offer the most potential in terms of providing the necessary scientific information. Atmosphere, composition, biology, and field and particles of Venus are discussed; and the various types of experiments required are described. M.W.R.

N67-32648# Lowell Technological Inst. Research Foundation, Mass.
SOLAR CORONA STUDY Final Report, 1 Feb. 1964–31 Oct. 1966
Koo Sun Kim Jan. 1967 19 p
(Contract AF 19(628)-3883)
(LTIRF-260/IP; AFCRL-67-0259; AD-652504) CFSTI: HC $3.00/MF $0.65

The observed latitude dependence of angular velocity in the solar photosphere and the hydrodynamical law of conservation of vorticity are used to develop real solutions for large scale photospheric meridional velocities. Analytically allowed regions for stationary, real velocity fields are obtained in qualitative agreement with the observed latitudinally restricted regions for sunspots. Author (TAB)

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see 30 Space Sciences. For related information see also 28 Propulsion Systems; and 32 Structural Mechanics.

N67-31527*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
FULL-SCALE FLIGHT TEST FROM SEA LEVEL OF AN ABORT-ESCAPE SYSTEM FOR A PROJECT MERCURY CAPSULE
Willard S. Blanchard, Jr. and James L. Raper Washington, NASA Oct. 1960 44 p refs
(NASA-TM-X-422) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

The system designed to provide safe escape for a Project Mercury manned capsule during the atmospheric part of the boosted flight was tested in free flight to determine its ability to function satisfactorily in case of booster rocket malfunction at, or near, take-off. The escape system consisted basically of a rocket motor mounted atop a tower, which was mounted atop the capsule, and a large landing parachute to provide a rate of descent sufficiently low to avoid injury to the occupant on the proposed manned flights. Author

N67-31529*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
A COMPILATION OF WIND-TUNNEL HEAT-TRANSFER MEASUREMENTS ON THE AFTERBODY OF THE PROJECT MERCURY CAPSULE REENTRY CONFIGURATION
Kenneth C. Weston and Joanna E. Swanson Washington, NASA Aug. 1961 31 p refs
(NASA-TM-X-495) CFSTI: HC $3.00/MF $0.65 CSCL 22C
(Declassified)

Wind-tunnel heat-transfer measurements on the Mercury conical section agree reasonably well with laminar theory and laminar or turbulent theoretical estimates satisfactorily account for the wide range of wind-tunnel heating measurements which have been obtained on the cylindrical section. A correlation of the conditions for the existence of laminar or turbulent cylindrical heat transfer is presented. Theory is also compared with free-flight data from a full-scale Project Mercury research and development test. Author

N67-31530*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRINCIPLE RESULTS FROM WIND-TUNNEL STABILITY TESTS OF SEVERAL PROPOSED SPACE CAPSULE MODELS UP TO AN ANGLE OF ATTACK OF 33°
Howard S. Carter, Ronald Kolenkiewicz, and Ronald D. English Washington, NASA, Sep. 1959 19 p refs
(NASA-TM-X-21) CSCL 22B (Declassified)

Tests were made in five wind tunnels using cone-shaped models with the large end upstream and with the center of gravity near the large end. The models had marginal static stability at low angles of attack for subsonic Mach numbers and somewhat higher static stability at all other angles of attack and Mach numbers of the investigation. Some forced-oscillation dynamic tests at subsonic speeds showed the oscillations to be damped. Author

N67-31531*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF VARIOUS MERCURY ESCAPE CONFIGURATIONS AND OF A PROPOSED ALTERNATE ESCAPE CONFIGURATION FOR MACH NUMBERS OF 0.05 TO 9.60
Robert P. Smith and William C. Moseley, Jr. Washington, NASA, Jul. 1961 180 p refs
(NASA-TM-X-494) CSCL 22B (Declassified)

A summary of the available wind-tunnel results on the static longitudinal stability characteristics of the basic Mercury escape configuration and modifications made to the basic escape configuration up to, but not including, present production configurations is presented. The tests covered a Mach number range from 0.05 to 9.60 at Reynolds numbers from 0.14×10 to 14.5×10 (based on capsule maximum diameter). Results are also presented for tests on a proposed alternate escape configuration. Author

N67-31833*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SIDESLIP CHARACTERISTICS AT VARIOUS ANGLES OF ATTACK FOR SEVERAL HYPERSONIC MISSILE CONFIGURATIONS WITH CANARD CONTROLS AT A MACH NUMBER OF 2.01
Gerald V. Foster Washington, NASA, Nov. 1959 24 p refs
(NASA-TM-X-134) CFSTI: HC $3.00/MF $0.65 CSCL 16D
(Declassified)

An investigation has been made in a 4-foot supersonic pressure tunnel to determine the aerodynamic characteristics at a Mach number of 2.01 of a series of hypersonic missile configurations. The configurations investigated included a body of revolution having a length–diameter ratio of 10, a body with a 10° flare at the base, and a body with cruciform fins of 5° or 15° apex angle at the base. The configurations with fins and flare were equipped with canard surfaces for pitch control. The results indicated large variations in normal force and pitching moment with sideslip angle due to canard-control deflection for both the finned and flared configurations; however, this effect diminished as the angle of attack increased. The canard controls, however, had little effect on the rolling-moment characteristics of the flared configuration; whereas, substantial induced roll was indicated for the finned configurations. Author

N67-31673# Library of Congress, Washington, D. C. Aerospace Technology Div.
SPACECRAFT CABIN ATMOSPHERES. A REVIEW OF SOVIET LITERATURE
Boris Mandrovsky *In its* Foreign Sci. Bull., Vol. 3, No. 4 Apr. 1967 p 1–37 refs (See N67-31672 18-34)

The literature is reviewed to determine the reasons underlying the selection of standard atmospheres for manned space flights. The article covers: the standards set for the Vostok and Voskhod flights; the results of preflight tests; actual cabin parameters maintained in flights; statements by Soviet scientists regarding the need to use altered cabin atmospheres for prolonged spaceflights; the pros and cons of various types of altered atmospheres; experiments dealing with the individual and combined effects of atmospheric components and factors (O_2, N_2, helium, CO_2, minor contaminants, temperature, humidity, low pressure, isolation, hypodynamia, and air ionization); and finally, the standards and permissible limits set for cabin parameters for future Soviet spaceflights. Author

N67-31689# Martin Co., Baltimore, Md.
ESTIMATE OF EFFECT OF SPACECRAFT VIBRATION QUALIFICATION TESTING ON RELIABILITY
Clyde V. Stahle, Jr. *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 1–8 refs (See N67-31688 18-32)

The effect is estimated of the test on the reliability of a spacecraft system, i.e., the probability that the spacecraft will perform satisfactorily while and after the spacecraft is subjected to the vibration of the launch phase of flight. The increase in the vibration reliability is quantitatively evaluated by a stress–strength reliability analysis which treats the vibration-induced spacecraft failures as resulting from log normal distributed equipment vibration stress and strength. The vibration stress distribution is formulated in terms of the equipment qualification test level and combined with the equipment strength distribution. An independent serial systems model is used to relate the vibration reliability of the equipment to that of the spacecraft. The vibration reliability of the spacecraft is formulated in terms of the equipment qualification test level and the number of equipments to be qualified. The estimated reliability is given for the range of vibration levels for which data were obtained. Author

N67-31690# Boeing Co., New Orleans, La.
S-IC RELIABILITY PROGRAM FROM STRUCTURAL LIFE VIEWPOINT
Roy L. Rich and James A. Roberts *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 19–25 ref (See N67-31688 18-32)

The critical hardware on the S-IC is defined and the methods used to show reliability of this critical hardware, emphasizing the structural aspects of the program, are discussed. Mechanical hardware, in which failures are chiefly attributable to fatigue, are proven reliable by a safe-life technique, developed using historical fatigue data established on airplanes. Components are proven capable of withstanding repeated life cycles of vehicle service environments by analysis and test. The vibration environments, hardware limitations, factors affecting the required life cycles, and test conditions are developed or defined. Reliability of electrical hardware is shown by comparing failure histories with maximum expected environments. Failures are caused by increasing, one at a time, the independent environments to which a component might be susceptible. Vibration environments, test conditions, and methods of establishing the reliability number are discussed. Author

N67-31692# Hughes Aircraft Co., El Segundo, Calif.
DYNAMIC ANALYSIS OF ATS-B SPACECRAFT
Saul M. Kaplan and Victor Terkun *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 41–62 refs (See N67-31688 18-32)

The analytical model and the digital computer techniques used in evaluating the dynamic characteristics and loads of the ATS-B Applications Technology Satellite are briefly described. A vibration test was performed on a structural test model of the ATS-B spacecraft. Comparisons of the test data with analytically predicted accelerations at various locations on the spacecraft structure and components are presented and show excellent agreement. Author

N67-31693# Republic Aviation Corp., Farmingdale, N. Y.
SPACECRAFT DESIGN FOR ATLAS TORSIONAL SHOCK TRANSIENT
Sol Davis *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 63–71 refs (See N67-31688 18-32)

The effect of the torsional vibration and shock inputs applied to the base of the spacecraft were expressed in terms of response spectra for several values of damping. The analysis indicates that very high responses will occur in torsional modes whose natural frequencies lie between 60 and 75 cps. These shock responses can be much more severe than the response to the torsional steady state vibration if torsional resonant frequencies lie between 50 and 80 cps. An analysis of the Advanced Orbiting Solar Observatory configuration designed by all other significant design criteria except torsion shock indicated that the fundamental primary structure torsional frequency would fall within the worst part of the critical frequency band. It was decided that the structural design should be modified to minimize the effects of the torsion shock transient on the experiments. The design criteria was established that the primary structure torsional natural frequency should be greater than 80 cps for all experiment array configurations. Author

N67-31695# Martin Co., Baltimore, Md.
GROUND-WIND-INDUCED OSCILLATIONS OF GEMINI–TITAN AIR VEHICLE AND ITS ERECTOR
John E. Tomassoni and William H. Lambert *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 79–88 (See N67-31688 18-32)

The program encompassed three phases: (1) Full-scale vibration tests in which dynamic characteristics of the air vehicle and erector were measured. (2) Model wind tunnel tests from which static and dynamic data were obtained for both the air vehicle and erector. (3) Measurement of full-scale wind-induced responses of the air vehicle and erector. Maximum base bending moments on the air vehicle were induced when it was in the turbulent wake of the erector. Dynamic responses of the model erector were small compared with static loads. The full-scale air vehicle data correlated well with the wind tunnel results. With respect to load magnitude, the full-scale data appear somewhat higher than model responses, possibly because of the added effects of atmospheric turbulence. Dynamic wind responses of the full-scale erector were very small. However, the transient responses induced by mechanical operations of raising and lowering the erector unexpectedly proved so significant that a wind restriction was imposed on the erector operations when the launch vehicle was erected. Author

N67-31696# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NOISE LEVEL MEASUREMENTS FOR IMPROVED DELTA, ATLAS/AGENA-D, AND TAT/AGENA-D LAUNCH VEHICLES
Lloyd A. Williams and William B. Teremak *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 89–102 refs (See N67-31688 18-32)

Acoustic noise data obtained during the launch are presented for the improved Delta, the TAT/Agena-D, and the Atlas/Agena-D. Acoustic noise data obtained within the shroud during major flight events, i.e., lift-off, transonic, and maximum dynamic pressure, are presented as well as levels measured external to the shroud during lift-off. Data comparisions of the various measurements, i.e., internal to external, vehicle to vehicle, and acoustic signature to spacecraft vibration signature, are made for the times of interest. Author

N67-31707* National Aeronautics and Space Administration, Washington, D. C.
OGO-D
21 Jul. 1967 44 p
(NASA News Release-67-187) Available from the Scientific and Technical Information Division CSCL 22B

A journalistic account is presented on the fourth Orbiting Geophysical Observatory and its expected flight. The orbit and flight data, and its operation are mentioned. Details are included on the experiments to be performed and the data to be obtained, emphasizing the interrelationships between particle activity, aurora and airglow, the geomagnetic field, the neutral and ionized composition of the atmosphere, and the electromagnetic energy sources contributing to ionization and atmospheric heating. The spacecraft is briefly described, and the power, attitude control, thermal control, communications, and data handling and processing systems are outlined. The Thor–Agena launch vehicle and its flight sequence are described. N.E.N.

N67-31712* National Aeronautics and Space Administration, Washington, D. C.
LUNAR ORBITER E
21 Jul. 1967 50 p
(NASA News Release-67-192) Available from the Scientific and Technical Information Division CSCL 22A

A NASA press kit release regarding the Lunar Orbiter E to be launched in August 1967 is presented. Information about the spacecraft configuration; the camera system; the photo taking, processing, and readout systems; and the electrical power, attitude control, velocity control, temperature control, and communications systems is given. Lunar Orbiter Tasks (photography and selenodesy tasks, and meteoroid and radiation measurements) are described. Also discussed are the Atlas–Agena D Launch Vehicle; the Deep Space Network facility for tracking the mission; and the countdown, flight, and space events for the mission. The management contractor, and industrial teams associated with the Lunar Orbiter E project, are listed. L.S.

N67-31728*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
MEASUREMENTS OF THE SURFACE FLOWS, HEAT TRANSFER, PRESSURE DISTRIBUTION, AND LONGITUDINAL STABILITY OF A MERCURY CAPSULE MODEL AT MACH NUMBERS OF 6.9 AND 9.6
Philip E. Everhart and Peter T. Bernot Washington, NASA, Apr. 1961 58 p refs
(NASA-TM-X-458) CSCL 22B (Declassified

Pressure-distribution and heat-transfer tests on a 0.03-scale model of the Mercury capsule reentry configuration were made in the Langley 11-inch hypersonic tunnel at a Mach number of 9.6, a Reynolds number of 240,000 based on the model maximum diameter, and an angle-of-attack range from 0° to 15°. Schlieren and oil-flow tests were made at Mach numbers of 6.9 and 9.6 in order to study the capsule flow field. Static longitudinal stability characteristics of the escape, exit, and reentry capsule configuration at a Mach number of 9.6 are also presented. Author

N67-31809*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
PRESSURE AND HEAT-TRANSFER MEASUREMENTS ON A MERCURY CAPSULE MODEL

John O. Reller, Jr. and H. Lee Seegmiller Washington, NASA, May 1962 85 p refs
(NASA-TM-X-647) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

The investigation was conducted at a Mach number of 4.95 and a Reynolds number of 15.7×10^6 based on body length. The angles of attack of the configuration referenced to the plane of the upper surface were 0°, 5°, and 10°. The pressures on the lower surface in the plane of symmetry approached the pressure that existing on a swept infinite cylinder within a distance from the apex of about 7 nose diameters—the nose diameter in the plane of symmetry being used as the reference. Because of the low range of crossflow Mach numbers in the present investigation, 0.92 to 1.75, no adequate prediction of the pressures elsewhere was made by either modified Newtonian or modified tangent-wedge approximations. Author

N67-31833*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
REQUIREMENT STUDIES FOR THE LAUNCH VEHICLE AND SUPPORT FOR A HORIZON DEFINITION SPACECRAFT
James O. Barrett and Richard T. LaFrois May 1967 132 p
(Contract NAS1-6010)
(NASA-CR-66375) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A flight vehicle operations and launch support plan compatible with the recommended spacecraft configuration and flight technique was developed during the Horizon Definition Study. This plan features a two-stage Improved Delta launch vehicle, Model DSV-3N, and launch operations from the Western Test Range. Author

N67-31884*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
APPLICATIONS TECHNOLOGY SATELLITE TECHNICAL DATA REPORT, VOLUME I
5 Jul. 1967 937 p
(NASA-TM-X-60082) CSCL 22B

Progress is reported in the development of the ATS-1 (B), the ATS-2 (A), and the satellite launch vehicles. Areas covered include ground stations; operations; microwave communications, VHF communications, and meteorological experiments; and orbit parameters. Significant results and conclusions, and delineations of anticipated problem areas and recommended actions are included. C.T.C.

N67-31920*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PRESSURE AND HEAT-TRANSFER DISTRIBUTION ON THE AFTERBODY OF A LISTING MERCURY-TYPE CAPSULE AT MACH NUMBER 15 IN HELIUM
Joseph G. Marvin Washington, NASA, Apr. 1963 31 p refs
(NASA-TM-X-783) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

Afterbody pressure and heat-transfer distributions, shock-wave shapes, and photographs of local flow conditions were obtained on a capsule configuration capable of a lifting entry. The test body consisted of a segment of a sphere attached to a rear-facing conical afterbody with a cone angle of 53°. The sphere radius was equal to the maximum body diameter. Data were obtained at Mach number 15 in helium, at a Reynolds number based on maximum body diameter of 1.5×10^6, and over an angle-of-attack range from 0° to 30°. The flow over the windward side of the afterbody changed from separated to attached with increasing angle-of-attack. At zero angle-of-attack, the heat-transfer coefficients agreed with a prediction for laminar separated flow obtained when measured surface pressures were used to determine local flow conditions. A heat-transfer coefficient peak on the windward side of the afterbody moved from the most rearward point on the afterbody toward the shoulder with increasing angle-of-attack. A method was developed to correlate heat-transfer rates measured in helium with those obtained in air. The method is used to compare wind-tunnel results with heating rates measured on the Mercury MA-5 flight. Author

N67-31969*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE STATIC STABILITY CHARACTERISTICS OF A REENTRY SPACECRAFT MODEL IN FREE FLIGHT FOR MACH NUMBERS FROM 2.62 TO 1.11 LAUNCHED AT AN ANGLE OF ATTACK OF 180°
J. W. Usry Washington, NASA, Dec. 1961 26 p refs
(NASA-TM-X-615) CSCL 22B (Declassified)

A small-scale model of a proposed manned-reentry spacecraft configuration was tested in free flight to determine whether it would aerodynamically recover from an intentionally induced tumbling motion. Results indicate that the model rotated to the nose forward position and continued to oscillate through large angles of attack ranging from ±160° at a separation Mach number of 2.62 to about ±140° at a Mach number of 1.11. The model was statically stable about the trim point for all test Mach numbers and angles of attack. Author

N67-31978*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
PERFORMANCE CHARACTERISTICS OF THE LITTLE JOE LAUNCH VEHICLE
Ronald Kolenkiewicz and John C. O'Loughlin Washington, NASA, Sep. 1962 74 p refs
(NASA-TM-X-561) CFSTI: HC $3.00/MF $0.65 CSCL 22D
(Declassified)

A summary of performance data is given for the first five Project Mercury Little Joe flights. Some of these data are compared with calculated performance characteristics and are shown to be in good agreement. Curves showing calculated maximum performance characteristics for the Little Joe launch vehicle are presented over a wide range of take-off weights, launch angles, and staging times as an aid in the prediction of performance parameters of the Little Joe launch vehicle when used in future projects. Author

N67-31979*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT TEST OF A LITTLE JOE BOOSTED FULL-SCALE SPACECRAFT MODEL AND ESCAPE SYSTEM FOR PROJECT MERCURY
Hal T. Baber, Jr., Howard S. Carter, and Roland D. English Washington, NASA, May 1962 53 p refs
(NASA-TM-X-629) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

The third flight test in the Little Joe program demonstrated the soundness of the escape-system concept for Project Mercury at conditions of low dynamic pressure and hypersonic speed. Analysis of atmospheric entry data indicated that the spacecraft was statically stable but dynamically unstable and that the maximum angle of attack experienced by the spacecraft was approximately 100°. A rhesus monkey onboard the spacecraft was successfully recovered with no apparent harm. Author

N67-32007*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
CONCEPTUAL MECHANIZATION STUDIES FOR A HORIZON DEFINITION SPACECRAFT STRUCTURES AND THERMAL SUBSYSTEM
Ivan W. Russell, David C. Peterson, Richard M. Jonsson, and Clarence A. Jansen May 1967 140 p refs

(Contract NAS1-6010)
(NASA-CR-66380) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The spacecraft conceptual configuration developed during the horizon definition study is a spin-stabilized, hexagonal cylinder configured for launch on a two-stage Improved Delta (DSV-3N). This configuration utilizes extended solar panels for primary power and incorporates passive radiation cooling of the spacecraft body. Separate thermal environments are provided for the experimental package and the supporting subsystem components. Author

N67-32009* Chrysler Corp., New Orleans, La. Space Div.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME I
Gary F. Romberg 15 Feb. 1965 791 p refs
(Contract NAS8-4016)
(NASA-CR-66580; TN-AE-65-72, Vol. I) CSCL 22D

Wind tunnel investigations were conducted on a 5.0 percent scale model of the Saturn IB vehicle to determine the detailed pressure and load distributions on the fins and tail area of the S-IB stage. Tests were performed to assist in evaluating the structural integrity of the S-IB stage. Data were obtained over a Mach number range of 0.70 through 1.35 and over an angle of attack range of −14.2 degrees to +14.2 degrees. Data are presented in tabular form for each test condition as coefficient of pressure and as a function of orifice number. Tabulated pressure coefficients are given in the tail area of the S-IB stage for the Saturn IB launch vehicle without turbine exhaust ducts, without S-IB stage fins, and with four Minuteman strap-ons. S.P.

N67-32010* Chrysler Corp., New Orleans, La. Engineering Dept.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME II
Gary F. Romberg 15 Feb. 1965 647 p For Abstract see N67-32009
(NASA-CR-66575; TN-AE-65-72, Vol. II) CFSTI: $3.00 CSCL 22D

N67-32011* Chrysler Corp., New Orleans, La. Engineering Dept.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME III
Gary F. Romberg 15 Feb. 1965 781 p For Abstract see N67-32009
(NASA-CR-66581; TN-AE-65-72; Vol. III) CFSTI: $3.00 CSCL 22D

N67-32012* Chrysler Corp., New Orleans, La. Engineering Dept.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME IV
Gary F. Romberg 15 Feb. 1965 606 p For abstract see N67-32009
(NASA-CR-66582; TN-AE-65-72, Vol. IV) CFSTI: $3.00 CSCL 22D

N67-32013* Chrysler Corp., New Orleans, La. Engineering Dept.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME V
Gary F. Romberg 15 Feb. 1965 1130 p For Abstract see N67-32009
(NASA-CR-66576; TN-AE-65-72, Vol. V) CFSTI: $3.00 CSCL 22D

N67-32014* Chrysler Corp., New Orleans, La. Space Div.
RESULTS OF A WIND TUNNEL INVESTIGATION TO DETERMINE THE DETAILED PRESSURE DISTRIBUTIONS ON THE S-IB STAGE FINS AND TAIL AREA OF THE SATURN IB VEHICLE, VOLUME VI
Gary F. Romberg 15 Feb. 1965 660 p ref For Abstract see N67-32009
(Contract NAS8-4016)
(NASA-CR-66583; TN-AE-65-72, Vol. VI) CSCL 22D

N67-32016*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 3.0 TO 6.8 OF THE STATIC AERODYNAMIC CHARACTERISTICS OF MODIFIED MERCURY EXIT AND ESCAPE CAPSULE CONFIGURATION
Albin O. Pearson Washington, NASA, Sep. 1960 19 p refs
(NASA-TM-X-324) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

The investigation was conducted in a 2-foot low-density hypersonic tunnel at angles of attack from about −5° to 25°. The modifications consisted of a destabilizer flap and increased parachute-housing diameter on the exit configuration and increased parachute-housing diameter and Marman clamp on the escape configuration. Author

N67-32018*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 0.60 TO 1.20 OF THE STATIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A POSSIBLE NONLIFTING REENTRY CAPSULE IN COMBINATION WITH A ROCKET BOOSTER
Albin O. Pearson Washington, NASA, Sep. 1960 16 p refs
(NASA-TM-X-318) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

Data are presented for a Mach number range from 0.60 to 1.20 at angles of attack from −9° to 9°. Reynolds numbers varied from about 1.18×10^6 to 1.57×10^6. The results indicate the model to be statically stable in pitch for the range of Mach numbers of the investigation. Removal of the escape rocket and tower did not affect the pitching-moment and normal-force coefficients but decreased the axial-force coefficients. Author

N67-32019*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE LOW-SUBSONIC AERODYNAMIC CHARACTERISTICS OF A MODEL OF A MODIFIED LENTICULAR REENTRY CONFIGURATION
George M. Ware Washington, NASA, Dec. 1962 28 p refs
(NASA-TM-X-756) CSCL 22B (Declassified)

An investigation consisting of force tests to determine the static longitudinal and lateral stability and control characteristics of the model was conducted. Tests were also made to determine the effects of fin incidence and dihedral and a fin pylon-body fairing. Author

N67-32118*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
GSFC PHASE A ANALYTICAL REPORT FOR ATS-F&G

Harry L. Gerwin. comp. Feb. 1967 295 p refs
(NASA-TM-X-55837; X-730-67-118) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Based on four separate studies, feasibility and practicability are discussed for a 30-foot diameter, deployable spacecraft antenna with good rf performance up to 10 GHz; as well as for providing spacecraft fine pointing (0.1 deg) and slewing (17.5 deg in 30 min), and an oriented stable spacecraft at synchronous altitude for advanced technology experiments. The approach considered preferred at the present time, the preferred system, is described and tradeoff analysis for this approach is detailed for each of the areas in the feasibility study. This includes launch vehicle selection, apogee motor, launch and ascent sequence; as well as the various spacecraft structure, antenna, thermal approach, communications, control, auxiliary propulsion, power, telemetry and command, environment, and ground support. Appendixes detail various experiments, antenna feedmast tradeoff and selection, closed loop use of the interferometer, reflector antenna beam scanning, and other findings. M.W.R.

N67-32123*# National Aeronautics and Space Administration, Washington, D. C.
A NEW METHOD OF APPROACHING THE DESIGN OF SOUNDING ROCKETS [SU UN NUOVO METODO PER L'IMPOSTAZIONE DEL PROGETTO DEI MISSILI SONDA]
E. Giamondi Jul. 1967 37 p refs Transl. into ENGLISH of the Spanish Presented at the XIII Intern. Telecommun. Meeting, Geneva, 12–16 Oct. 1965
(NASA-TT-F-489) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A very simple calculating method for precisely determining the principal characteristics of a rocket that meets the requirements set forth by the design problem is presented. The method may also be used to compare the influence of some parameters on the characteristics and the performance of rockets. The method proposed has been applied to analytical solutions which require only a certain amount of simplification and which can be eliminated with iteration. Author

N67-32136*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.
EFFECTIVENESS OF SEVERAL CONTROL ARRANGEMENTS ON A MERCURY-TYPE CAPSULE
Robert I. Sammonds and Robert R. Dickey Washington, NASA, Oct. 1961 35 p refs
(NASA-TM-X-579) CFSTI: HC $3.00/MF $0.65 CSCL 22B
(Declassified)

The trim effectiveness of three types of aerodynamic controls (flaps) on a Mercury-type capsule and their effect on the static and dynamic stability of the capsule was determined in a wind tunnel at M = 3.3 and in free flight at M = 5.5 at Reynolds numbers of 1.25 and 0.1 million, respectively, based on the maximum face diameter. Results of these investigations have shown that a flap consisting of a forward extension of the conical surface of the afterbody ahead of the spherical front face and having an area equal to approximately 6-1/2 percent of the capsule frontal area would trim the capsule at −29° angle of attack, with a lift-drag ratio of approximately 0.45. Author

N67-32138*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
LAUNCH-VEHICLE DYNAMICS
Harry L. Runyan, Jr., and A. Gerald Rainey Washington, NASA, Dec. 1961 13 p refs
(NASA-TM-X-607) CFSTI: HC $3.00/MF $0.65 CSCL 22D
(Declassified)

Structural-dynamics problems pertinent to the design of launch vehicles suitable for a lunar mission are discussed. Some measurements of the natural modes of a model of the Saturn launch vehicle are presented. Recent information concerning launch-vehicle loads associated with buffeting, aerodynamic noise, and winds is also presented. Author

N67-32148*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
STATIC AERODYNAMIC CHARACTERISTICS OF A 1/9-SCALE MODEL OF THE ESCAPE AND EXIT CONFIGURATIONS OF THE PROJECT MERCURY SPACECRAFT AT MACH NUMBERS FROM 2.30 TO 4.65
Roger H. Fournier Washington, NASA, Sep. 1962 27 p refs
(NASA-TM-X-701) CSCL 06G (Declassified)

The model was tested in the escape and exit configurations through angle of attack ranges representing the maximums expected for each configuration. The model tested during this investigation is a modified version of a previously tested model of the Mercury spacecraft. The modifications include an enlarged parachute canister, a Marman clamp, and a flap-type destabilizer. The Reynolds numbers varied from 2.20×10^6 to 5.22×10^6. Author

N67-32181# European Space Research Organization, Paris (France).
SPACECRAFT TECHNOLOGY. VOLUME V: SPACE ENVIRONMENT
Dec. 1966 218 p refs Proc. of 2d ESRO Summer School, Oxford, 1964
(ESRO-SP-13) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. SPACE ENVIRONMENTS: THEIR EFFECTS ON SPACECRAFT DESIGN S. L. Entres (European Space Technol. Center) 17 p (See N67-32182 18-31)

2. VACUUM CONDITIONS AND THEIR ATTAINMENT IN THE LABORATORY 68 p refs (See N67-32183 18-11)

3. THE THERMAL ENVIRONMENT IN SPACE L. A. Husain (European Space Technol. Center) 19 p refs (See N67-32184 18-31)

4. THERMAL ENVIRONMENT SIMULATION L. A. Husain (European Space Technol. Center) 18 p refs (See N67-32185 18-11)

5. THE METEORITE ENVIRONMENT OF EARTH SATELLITES S. L. Entres (European Space Technol. Center) 12 p refs (See N67-32186 18-30)

6. SATELLITES AND CHARGED CORPUSCULAR RADIATION M. J. Downey (RAE) 56 p refs (See N67-32187 18-29)

7. A REVIEW OF ZERO-GRAVITY RESEARCH AT THE ROYAL AIRCRAFT ESTABLISHMENT J. Porter (RAE) 24 p refs (See N67-32188 18-31)

N67-32182# European Space Technology Center, Delft (Netherlands).
SPACE ENVIRONMENTS: THEIR EFFECTS ON SPACECRAFT DESIGN
S. L. Entres *In its* Spacecraft Technol. Vol. V Dec. 1966 17 p *Its* Lecture 40 (See N67-32181 18-31)

The space environment itself, and problems in space simulation for spacecraft and component testing are summarized. Emphasis is placed on the combination of the electromagnetic radiation, thermal, and weightlessness environments. The heat balance, temperature determination and control, and radiative heat transfer are discussed, and it is pointed out that solar radiation simulation is expensive and difficult. Corpuscular radiations from the Van Allen belt, solar storms, solar wind, and cosmic radiation are considered briefly. The problems in predicting the effect of weightlessness are described, and the difficulties in using free-fall testers are identified. Vacuum, magnetic fields, and meteoric flux are mentioned. N.E.N.

N67-32184# European Space Technology Center, Delft (Netherlands).
THE THERMAL ENVIRONMENT IN SPACE
L. A. Husain *In its* Spacecraft Technol. Vol. V Dec. 1966 19 p refs *Its* Lecture No. 42 (See N67-32181 18-31)

The characteristics of the main heat sources and sinks which interact with a spacecraft in earth orbit are reviewed. The basic thermal relationship is described, and the problem areas in solving the equation for the steady state mean temperature are listed. The variations of the atmospheric influence with altitude are tabulated. The parameters of the solar radiation are reviewed, and the absorptivities and emissivities of passive thermal coatings for reflectors and absorbers are given. Reflectances are included for the earth albedo for cloud cover and various topographical features. The thermal radiation from the earth is also briefly described. It is emphasized that present day knowledge of these last two quantities do not permit accurate predictions, but that their contribution to the thermal balance of a spacecraft is small compared with that of the sun. N.E.N.

N67-32188# Royal Aircraft Establishment, Farnborough (England).
A REVIEW OF ZERO-GRAVITY RESEARCH AT THE ROYAL AIRCRAFT ESTABLISHMENT
J. Porter *In its* Spacecraft Technol. Vol. V Dec. 1966 24 p refs *Its* Lecture No. 48 (See N67-32181 18-31)

Zero g simulation methods and test facilities are briefly discussed, and an application to a satellite fuel tank design is presented. The free-fall tower is considered the most readily available, cheap, and flexible method, and a 36-ft tower test facility is mentioned. The ballistic trajectories of aircraft for floating experiments, and the equipping of a Canberra aircraft for such experiments are described. The problems, involved in designing a two-phase liquid–vapor system so that liquid propane is supplied to the valve at up to 1/3 cc/sec, are identified. The standpipe for locating the liquid, fuel utilization, and heat and mass transfer are discussed. Design evaluation tests for the fuel tank system are also mentioned. N.E.N.

N67-32306*# National Aeronautics and Space Administration, Washington, D. C.
M2–F2 LIFTING BODY ACCIDENT SUMMARY
1 Aug. 1967 6 p refs
(NASA News Release-67-205) Available from the Scientific and Technical Information Division CSCL 22B

A summary is presented of the findings of an investigating board appointed to examine the report on the May 10, 1967 landing accident involving the M2–F2 lifting body research vehicle. Factors leading to the accident were determined, and results were analyzed, and recommendations are made to minimize the possibility of similar occurrences in future flights. It was found that the immediate cause of the accident was an unusually low landing flare maneuver and premature ground contact. C.T.C.

N67-32307*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AIMP-I EXPLORER XXXII Second Interim Flight Report
Jeremiah J. Madden May 1967 40 p refs
(NASA-TM-X-55838; X-724-67-223) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Data on the performance and orbital characteristics of the AIMP-I (Anchored Interplanetary Monitoring Platform) (Explorer XXXIII), which was launched on July 1, 1966, are presented. Cited are data for the period October 1966 through March 1967. Earlier data are included for comparison. The AIMP-I is in an orbit about the earth in which the perigee position varies from 26,000 km to 130,000 km and the apogee position from 400,000 km to 530,000 km. On January 1, 1967 the AIMP-D mission was declared a success, the spacecraft having passed its sixth month of active life. Discussed are the status of the spacecraft, battery failures; turn-on anomalies, spin axis/sun angle and spin rate; and performance parameters. Tabulated are a new set of predictions for use in determining orbital elements of the spacecraft. S.C.W.

N67-32328# White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.
OPERATION MANUAL FOR STRATOSPHERE TEMPERATURE SONDE
Bruce Kennedy Ft. Monmouth, N. J., Army Electron. Command Mar. 1967 23 p refs
(ECOM-5114; AD-653003) CFSTI: HC $3.00/MF $0.65

This report provides instructions for the operation of the Stratosphere Temperature Sonde. Author (TAB)

N67-32334*# Boeing Co., Seattle, Wash.
LUNAR ORBITER I: PHOTOGRAPHY
Washington, NASA, Aug. 1967 125 p
(Contract NAS1-3800)
(NASA-CR-847; D2-100727-2) CFSTI: $3.00 CSCL 22B

A complete description is presented of the reconstructed and reassembled photographs taken by Lunar Orbiter I. These photographs provide data on 262,000 square kilometers of the Moon's nearside to a level of detail over two orders of magnitude better than can be obtained from Earth. In addition, 45 medium- and high-resolution frames were exposed to nearside and farside areas of special interest, including an oblique view of the Moon's farside eastern limb with the Earth in the background. In all, over 3,000,000 square kilometers of the farside were photographed at a resolution of 250 meters, of which over 400,000 square kilometers were taken at a resolution of about 30 meters. All data required to identify and analyze these pictures, and a brief description of the photographic subsystem functions are included. C.T.C.

N67-32336*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
OPERATION PLAN 18–67 OFFICE OF NAVAL RESEARCH/RICE UNIVERSITY SATELLITE AURORA-1
Jun. 1967 65 p
(NASA-TM-X-55849; X-513-67-298) CSCL 22A

Responsibilities, organization, operations and control, and field station and computational support are detailed for the mission of Aurora-1 spacecraft, which will study auroras and airglow light emitted by the atmosphere in the northern hemisphere as well as charged particles and Van Allen radiation. Project implementation during the launch phase, orbital parameters, telemetry system, and power supply are considered. Attention is given to the communication center operations, data processing, and the composite countdown schedule. Aurora-1 signal strength calculations and potential rf conflicts are noted, and STADAN field station responsibilities are tabulated. M.W.R.

N67-32338*# National Aeronautics and Space Administration, Washington, D. C.
SOLAR PROBE WITH BURNER II PROPULSION MODULE [SONNENSONDE MIT BURNER II ANTRIEBSMODUL]
Aug. 1967 17 p Transl. into ENGLISH of Boelkow GmbH Pamphlet RF 77-ST/A II 19 p
(NASA-TT-F-11214) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Orbits and power outputs that can be achieved by various solid-fuel motors are detailed, and the optimal characteristic values for a solid-fuel propulsion system to put a solar probe into orbit are determined. The Burner II stage propulsion module for the Atlas Centaur vehicle is described, and the implications of using this module in the design of a solar probe are discussed. Weight balances and other aspects of such a solar probe are noted; solar plasma, magnetic field, cosmic radiation, zodiacal light, and

micrometeoroid experiments for the solar probe. Venus swingby and a distant flight past Mercury are noted as possible missions. M.W.R.

N67-32339*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
EQUILIBRIUM ANALYSIS AND ITS APPLICATION TO ATTITUDE CONTROL SYSTEMS
William N. Redisch Washington, NASA, Aug. 1967 127 p refs
(NASA-TR-R-270) CFSTI: HC $3.00/MF $0.65 CSCL 09C

A stability approach is developed that utilizes a computer simulation in conjunction with theoretical techniques to locate the potentially troublesome regions of state space and explore their acceptability. It is shown that for general physical systems all limit cycles are associated with equilibrium points that lie "inside" the limit cycles. Thus, if no equilibrium point exists in a region, then no limit cycle is contained in that region. Special properties of limit cycles and equilibrium points are discussed and illustrated. Equilibrium points are found analytically for spacecraft attitude controls systems. A method is devised to determine stability near these equilibrium points. Then, instead of utilizing a uniform or random n-dimensional grid of computer initial conditions, a grid is concentrated around a few calculated points. Several practical examples of actual systems are presented. When control systems are reviewed in this light, a high degree of confidence is gained from far fewer computer runs than previously needed. Author

N67-32369*# Hughes Aircraft Co., El Segundo, Calif.
SPACECRAFT ATTITUDE CONTROL GAS SYSTEMS ANALYSIS Final Report
Apr. 1967 230 p Prepared for JPL
(Contracts NAS7-100; JPL-951720)
(NASA-CR-86661; SSD-70172R) CSCL 22C

Reported are results of comparative analyses of six candidate systems for execution of the attitude control and maneuvering requirements of a future unmanned planetary probe/lander vehicle. The systems compared were: (1) stored cold gas (nitrogen and others); (2) vaporizing liquid plenum (ammonia and others); (3) hydrazine catalytic plenum (warm or ambient gas); (4) water electrolysis plenum; (5) hydrazine electrolysis plenum; and (6) dual mode hydrazine (hydrazine electrolysis plenum/hydrazine monopropellant thruster). All propulsion systems were examined in each of 14 different configurations for which weights and reliabilities were estimated. The two systems of greatest promise on the basis of weight and potential reliability were the hydrazine catalytic plenum and the dual mode hydrazine. It was also found that either of the two preferred systems can be employed in a fully redundant two-plenum configuration with both weight and reliability advantages over the best nitrogen cold gas system, even if the latter were used with a single plenum. The preferred configuration is, therefore, two plenums, each employing a pair of dual valve thrusters for each control function. If the larger total impulse requirement is imposed, the dual mode hydrazine system is preferable; if the smaller total impulse requirement is satisfactory, the hydrazine catalytic plenum is selected. S.C.W.

N67-32376*# University of Southern Calif., Los Angeles.
COMPENDIUM OF NOTES FOR THE 1967 N.A.S.A. SUMMER INSTITUTE
1967 301 p refs Inst. held at Univ. of Southern Calif., Los Angeles, 19 Jun.–28 Jul. 1967
(Contract NSR-05-018-055)
(NASA-CR-86916) CSCL 22B

Spacecraft functional design, guidance and control, systems engineering, and communications are reviewed in a space technology training program. The aspects of rocket propulsion, structural design, thermal control, and the planetary atmosphere are considered with respect to functional design. Discussions of space guidance and control include Laplace transformation and block diagrams; and feedback, space vehicle, and tracking systems. An introduction to systems engineering describes linear programming, decision theory, and astrodynamics approach. Studies in the field of space communications involved amplifiers and antennas; analogue and pulse modulation; data compression; spacecraft tracking; and systems for Pioneer, Ranger, and Mariner spacecraft. S.P.

N67-32388*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME I: SUMMARY AND PROBLEM IDENTIFICATION Final Report
J. F. Baxter Jul. 1967 53 p
(Contract NAS1-6607)
(NASA-CR-66404) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The feasibility studies in the areas of mode mobility, instrumentation, communications, power system, tradeoff, and problem identification are summarized. The inflatable buoyant station is to be deployed in the Venus atmosphere, and a small station compatible with an early mission employing an Atlas/Centaur launch vehicle was emphasized. It was concluded that scientific missions would be significantly enhanced by a buoyant station surviving for long periods, sampling vertical profiles in the atmosphere, and drifting over the surface. It was also concluded that a usable payload could be supported but that actual experience needs to be further developed in deployment and control techniques, and design and testing. N.E.N.

N67-32389*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME II: MODE MOBILITY STUDIES Final Report
R. E. Frank and J. F. Baxter Jul. 1967 93 p ref
(Contract NAS1-6607)
(NASA-CR-66405) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Five deployment methods are defined for a buoyant station. All methods use a parachute to produce low dynamic pressure conditions for balloon inflation. Altitude cycling feasibility is investigated. The results of a survey of government agencies and commercial suppliers of balloon materials are discussed. Three inflation gasses are considered for the mission—hydrogen, helium, and decomposed hydrazine. Author

N67-32391*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME IV: COMMUNICATIONS AND POWER Final Report
J. D. Pettus, A. A. Sorenson, and J. F. Baxter Jul. 1967 67 p refs
(Contract NAS1-6607)
(NASA-CR-66407) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The telecommunication portion of the feasibility study is discussed. Parametric bounds and variables are identified, and trade study results are presented. The power requirements for each buoyant station studied and the capability of the various types of systems to meet the requirements are presented. Author

N67-32392*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME V: TECHNICAL ANALYSIS OF A 200-POUND BVS Final Report
A. R. Barger, R. E. Frank, J. D. Pettus, A. A. Sorensen, and J. F. Baxter Jul. 1967 60 p refs
(Contract NAS1-6607)
(NASA-CR-66408) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Results are presented of an analysis of the feasibility of a small, nominally 200-lb, buoyant Venus station that would be compatible with a 1972 Atlas/Centaur-launched mission to Venus. Results indicate that the concept is both feasible and attractive.

Major development areas that would be associated with this concept are identified. Author

N67-32393*# Martin Co., Denver, Colo.
BUOYANT VENUS STATION FEASIBILITY STUDY. VOLUME VI: TECHNICAL ANALYSIS OF A 2000 AND 5000 LB. BVS Final Report
R. E. Frank and J. F. Baxter Jul. 1967 84 p ref
(Contract NAS1-6607)
(NASA-CR-66409) CSCL 22A

The results of an analysis of the feasibility of a 2000-lb buoyant Venus station are presented. This vehicle is intended to complement a Voyager-class mission to Venus. The 2000-lb weight is neither optimum nor restrictive. The large payload and mobility and long life make the station particularly suitable as a platform for experiments of the Voyager missions. It is also reasonable to project a 5000-lb or larger station for as yet undefinable future missions. Author

N67-32399*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
NATURAL ENVIRONMENT DESIGN CRITERIA GUIDELINES FOR MSFC VOYAGER SPACECRAFT FOR MARS 1973 MISSION
Don K. Weidner and C. L. Hasseltine, ed 8 Jun. 1967 100 p refs
(NASA-TM-X-53616) CSCL 22B

The information presented is based upon the results of inhouse studies and data taken from existing literature; a report bibliography is included. The environmental parameters examined pertain to the earth's environment, the interplanetary environment between Earth and Mars, and the Martian environment surface to 10 Mars radii. Figures are used extensively to amplify the text, and tabulated data are given on a mean model and 99% confidence envelope for the Mars atmosphere. M.G.J.

N67-32500*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
SYSTEMS ANALYSIS AND INTEGRATION STUDIES FOR A 15-MICRON HORIZON RADIANCE MEASUREMENT EXPERIMENT
William E. Eckstrom and Henry W. Berry May 1967 171 p
(Contract NAS1-6010)
(NASA-CR-66377) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Systems analysis and integration established the basic conceptual design requirements, identified the program functions, presented the system studies leading to the description of the recommended system, and established the program operational plan. The basic requirements are discussed in terms of radiometric, spacecraft, compatibility, and error analysis. The functional analysis contained the operations required for the prelaunch, orbital, and ground phases of the program. The systems studies discussed evolution from the multiple concepts considered for the various spacecraft subsystems to a single concept; and, finally, to recommend a system mechanization following effectiveness consideration including reliability. Author

N67-32621*# Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
A STUDY OF DATA REQUIREMENTS, SYSTEM CONSTRAINTS, OPERATIONAL METHODOLOGY AND DATA ANALYSIS TECHNIQUES FOR A 15-MICRON HORIZON RADIANCE MEASUREMENT EXPERIMENT
Roy E. Peterson, John R. Thomas, William F. Vogelzang, and Bruce F. Watson May 1967 319 p refs
(Contract NAS1-6010)
(NASA-CR-66379) CSCL 22B

The conceptual design for a satellite experiment was based on a comprehensive analysis of the required number of radiance profile samples for a global, one-year measurement program. These requirements are defined in terms of the numbers of space/time cells and profile samples/cell necessary for analyzing latitudinal, longitudinal, seasonal, and synoptic variations in horizon radiance. A total of approximately 360,000 profiles/year are required, covering a global set of 588 space cells and 13 time cells (each 28 days long). A variable data acquisition rate of 0.43–1.00 profiles/min was selected to afford requisite levels of data coverage within different latitude intervals. In addition, requirements were established for diurnal data sampling; these requirements led to the choice of a 3 o'clock (nodal crossing) sun-synchronous orbit. An extensive analysis of radiometer calibration, drift, and noise errors established tradeoffs between the radiometer design specifications and the experiment design requirements. Other design interfaces include those with the data handling, power, and attitude control subsystems. The effect of various operational alternatives, options, and contingencies was considered. In addition, definition was made of requirements and methodology involved in data reduction, analysis, and application. Author

N67-32552*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PANEL FLUTTER STUDIES OF BOOST-VEHICLE FULL-SCALE FLIGHT INSULATION PANELS
Michael L. Nacht and Richard L. Greene Washington, NASA, Aug. 1967 17 p refs
(NASA-TM-X-1417) CFSTI: HC $3.00/MF $0.65 CSCL 22D

Two full-scale quarter-segment Centaur flight insulation panels were tested in the Lewis 10- by 10-foot supersonic wind tunnel over a Mach number range of 2.0 to 3.5 at a 0° angle of attack. The test objective was to determine the ability of the panels to resist flutter under conditions simulating the flight environment. Mach number, dynamic pressure, and panel tension were the primary test variables, and liquid nitrogen was employed to produce cryogenic temperatures on the underside of the panels. Analytical comparison of panel characteristics with a conservative flutter criteria which neglected the stiffness of the supporting tank indicated that panel resistance to flutter was questionable. Examination of strain-gage output used to detect panel movement during the tunnel tests revealed that no flutter was experienced by the panels at any of the test conditions. Author

N67-32582*# National Aeronautics and Space Administration, Washington, D. C.
SURVEYOR III A Preliminary Report
Jun. 1967 170 p refs
(NASA-SP-146) CFSTI: HC $3.00/MF $0.65 CSCL 22B

CONTENTS:

1. TELEVISION OBSERVATIONS FROM SURVEYOR III E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al p 9–59 refs (See N67-32583 18-31)

2. SOIL MECHANICS SURFACE SAMPLER: LUNAR SURFACE TEST AND RESULTS R. F. Scott, F. I. Roberson, and M. C. Clary p 61–93 (See N67-32584 18-31)

3. LUNAR SURFACE MECHANICAL PROPERTIES E. M. Christensen, S. A. Batterson, H. E. Benson, R. Choate, L. D. Jaffe et al p 94–120 refs (See N67-32585 18-30)

4. LUNAR TEMPERATURES AND THERMAL CHARACTERISTICS J. W. Lucas, J. E. Conel, W. A. Hagemeyer, C. B. Jones, J. M. Saari et al p 121–137 refs (See N67-32586 18-30)

5. LUNAR SURFACE ELECTRICAL PROPERTIES W. E. Brown, R. A. Dibos, G. B. Gibson, D. O. Muhleman, W. H. Peake et al p 139 (See N67-32587 18-30)

6. LUNAR THEORY AND PROCESSES D. Gault, R. Collins, T. Gold, J. Green, G. P. Kuiper et al p 141–166 refs (See N67-32588 18-30)

N67-32583*# National Aeronautics and Space Administration, Washington, D. C.
TELEVISION OBSERVATIONS FROM SURVEYOR III
E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al *In its* Surveyor III, A Prelim. Rept. Jun. 1967 p 9–59 refs (See N67-32582 18-31)

Television pictures transmitted from lunar surface by Surveyor III showed small craters, linear ridges and troughs, and fragmental debris at random distribution. Degree of burial measurements on blocks in the lunar surface showed that their rounded tops above the surface had burial factors approaching 1, whereas rocks sitting on the surface had burial factors approaching 0. No significant linear correlation was established between roundness and burial depth for blocks in a given field. Size distribution of strewn fragments resembled the size distribution of fragments ejected from impact craters formed in strong rock. Imprints in the lunar surface material at touch-down points indicated that the fine-grain material was relatively incompressible. Photometric observation of the lunar surface established a luminescence factor of about 8.5% for the undisturbed area. Calorimetric measurements showed a relatively uniform gray color for the undisturbed surface. Included were also photographs of earth pictures telemetered from the spacecraft. G.G.

N67-32584*# National Aeronautics and Space Administration, Washington, D. C.
SOIL MECHANICS SURFACE SAMPLER: LUNAR SURFACE TEST AND RESULTS
R. F. Scott, F. I. Roberson, and M. C. Clary *In its* Surveyor III, A Prelim. Rept. Jun. 1967 p 61–93 (See N67-32582 18-31)

Results of tests performed by the soil sampler on the lunar surface are presented together with some conclusions on the mechanical properties of the surface material, as deduced from test materials. Brief evaluation of the soil sampler behavior and photographic results indicated a possibility that the lunar material becomes stronger and denser with depth. Bearing tests under a high Sun angle showed that soil disturbance took place to a distance of 10 to 12.5 cm; impact tests from a drop height of 60 cm compared with similar laboratory tests on densely packed dry sand. G.G.

N67-32636# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
THE SE-5 RUBIDIUM-85 VAPOR MAGNETOMETER
W. E. Radford Feb. 1967 43 p refs
(Contract NOw-62-0604-c)
(TG-890; AD-652807) CFSTI: HC $3.00/MF $0.65

Satellite 1964 83C was launched on December 13, 1964, into a nearly circular polar orbit, with inclination 89.993 degrees, period 106.3 minutes, perigee 1019 km, and apogee 1094 km. The satellite contains a Rubidium-85 vapor magnetometer, which successfully mapped, at middle and low latitudes, the geomagnetic field in the region traversed while the satellite was within telemetry range of a network of ground stations. These data are being analyzed in studies relating to the analytic description of the geomagnetic field and to the magnetic effects of quiet-time currents in the lower ionosphere and of magnetic storm-time currents in the Van Allen zones of trapped radiation. The present report discusses the elements relevant to the magnetometer assembly, pre-flight tests, in-flight calibrations, and some of the geomagnetic data obtained. Author (TAB)

N67-32674# Air Force Systems Command, Kirtland AFB, N. Mex. Weapons Lab.
MEASUREMENTS OF SPACECRAFT CABIN RADIATION DISTRIBUTIONS FOR THE FOURTH AND SIXTH GEMINI FLIGHTS, 1 JANUARY 1964–1 OCTOBER 1966
Joseph F. Janni Mar. 1967 46 p refs
(AFWL-TR-65-149; AD-651969) CFSTI: HC $3.00/MF $0.65

Five passive dosimetry packages were placed aboard the Gemini-4 and Gemini-6 spacecraft at points of maximum, minimum, and intermediate shielding. Each passive dosimetry package contained the following dosimeters: photoluminescent glass, lithium fluoride and calcium fluoride thermoluminescent dosimeters, discharge ionization chambers, nuclear emulsions, activation foils, and disks of cellulose nitrate plastic. The relationship of the spacecraft shielding to the experimental results and the response of the detectors to charged particles are discussed. The greatest variation in readings between the results from any two packages on the same flight was a factor of 2. As anticipated, there was a general trend of increasing total dosage with mission length, and decreasing dose with increasing overall shielding. The majority of the particles that penetrated into the spacecraft cabin were protons. Author (TAB)

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-31512# Applied Technology Associates, Inc., Ramsey, N. J.
TRANSIENT AND HARMONIC RESPONSES OF A PLATE WITH AN ATTACHED VISCOELASTIC LAYER
I. W. Jones, V. L. Salerno, and M. Morduchow Apr. 1967 49 p refs
(Contract N00014-66-C0028)
(ATA-115; AD-653312) CFSTI: HC $3.00/MF $0.65

The principle of elastic-viscoelastic analogy is applied to a differential equation for a two-layered plate. The results are response formulas for the transverse motion of a rectangular simply supported elastic plate with a viscoelastic damping layer attached. Expressions are given for both transient response and steady-state harmonic response. As special cases, formulas are derived for the response to step forces and for a concentrated force at the center. Numerical examples are included. TAB

N67-31838*# National Aeronautics and Space Administration, Ames Research Center, Moffet Field, Calif.
PROJECTILE SIZE EFFECTS ON HYPERVELOCITY IMPACT CRATERS IN ALUMINUM
B. Pat Denarod, James L. Summers, and C. Robert Nysmith Washington, NASA, Jul. 1967 14 p refs
(NASA-TN-D-4067) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Hard aluminum (2017-T4) spheres with diameters, d, of 1/16, 1/8, 1/4, and 1/2 inch were launched, in sabots, into thick targets of hard (2124-T4) and soft (1100-0) aluminum at velocities up to 28,000 ft/sec. Momentum transferred to the target during impact was measured by means of a simple ballistic pendulum to which the target was attached. The ratio of target momentum to projectile momentum increased with increasing projectile diameter, clearly demonstrating a projectile-size effect. The effects of the projectile size were determined quantitatively from the depth, P, of the crater and its diameter, volume, and shape. In the hypervelocity regime, the dimensionless penetration, P/d, varied with projectile diameter to the 1/18 power for the conditions of this experiment. Author

N67-31639*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF INITIAL LOADS AND OF MODERATELY ELEVATED TEMPERATURE ON THE ROOM-TEMPERATURE FATIGUE LIFE OF Ti-8Al-1Mo-1V TITANIUM-ALLOY SHEET
L. A. Imig Washington, NASA, Aug. 1967 24 p
(NASA-TN-D-4061) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The effect of high initial tensile or compressive loads and exposures up to 30 days at 300° and 550°F (422° and 561°K) on the room-temperature fatigue life of notched Ti–8Al–1Mo–1V titanium-alloy sheet was investigated. A high initial tensile load caused an increase in fatigue life and a high initial compressive load caused a decrease. Calculations showed that the tensile load caused compressive residual stress (which increased fatigue life) and that the compressive load caused tensile residual stress (which decreased fatigue life). Short duration exposure to elevated temperature caused a decrease in fatigue life. Longer exposures did not cause further reductions in fatigue life. Author

N67-31827*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AEROELASTIC CONSIDERATIONS
Robert W. Boswinkle, Jr. and E. Carson Yates, Jr. *In its* Proc. of NASA Conf. on Supersonic-Transport Feasibility Studies and Supporting Res. Dec. 1963 p 365–380 refs (See N67-31606 18-02)

Problem areas which involve combinations of aerodynamic, elastic, and inertial forces are considered in relation to the design of the supersonic transport. Some problems of ground loads, buffet, flutter, panel flutter, gust loads, and a consideration of aeroelastic effects on stability and control are discussed. Aeroelastic–dynamic considerations will be very important in the design and flight test phases of the supersonic transport; however, in general, the techniques for handling the problems which will arise appear to be reasonably adequate. Author

N67-31647 Lockheed Missiles and Space Co., Palo Alto, Calif.
FINITE DISPLACEMENTS OF A SOLID SUBJECTED TO THE ROTATION OF INTERNAL FLYWHEELS AND TRANSLATIONAL MOTION OF MASS
V. G. Aver'ianova and F. M. Dimentberg [1967] 11 p refs Transl. into ENGLISH from Inzh. Zh. (USSR), no. 2, 1967 p 3–11

The general case when rotations are communicated to a body by rotations of two flywheels on it, and by translational displacements with the aid of reactive impulses, the problem of finite displacements of a solid is solved. Spiral motions of a body are considered for which the position of the center of inertia is not conserved. The problem is solved on the basis of a geometric interpretation of slip and the decomposition of the finite spiral displacements of a solid. The solution is carried out by analogy with the solution of the problem of simple rotations of a solid. Formulas of spiral calculus are used because of the necessity to describe spiral displacements. R.U.

N67-31650 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE MECHANICS OF PLASTIC MEDIA
L. M. Kachanov [1966] 6 p refs Transl. into ENGLISH from Prikl. Mat. i Mekh. (Moscow), v. 4, no. 3, 1940 p 37–42

Plastic deformation theory is reviewed and consideration given to a continuous isotropic medium. This medium possesses the following properties: (1) At each point of the medium, the strain tensor is a linear function of the stress tensor; (2) The change in density of the medium is proportional to the mean pressure. (3) The increment in the specific work of the strain is an exact differential. Hencky formulas are reproduced in the following concepts: existence conditions for the potential of the strain work, work of the external forces, the rule of possible displacements, and rule of possible changes in the stress state, and rule of least work for the Hencky plastic medium. R.U.

N67-31651 Lockheed Missiles and Space Co., Palo Alto, Calif.
STABILITY OF SHELLS OF REVOLUTION TAKING ACCOUNT OF INITIAL DEFLECTIONS
S. S. Kan [1966] 12 p refs Transl. into ENGLISH from Samoletstr. i Tekhn. Vozdushn. Flota (USSR), no. 7, 1966 p 70–80

Classical theory is reviewed on the stability of shells of revolution taking into account the initial deflections. A discussion is presented on the admissibility of considering not the whole shell but only some domain within the limits of the length of one dent or buckling along the generator if the structure buckles with the formation of a set of waves, in order to seek the critical force. A shell of revolution with arbitrary curvature of the generatrix, loaded by an axial compressive loading is examined. Mathematical expressions are derived for the deformation of the middle surface of the structure during buckling. Tabular data show the sensitivity of the shell to changes in curvature associated with an initial deflection. The mechanism can be explained for buckling of cylindrical, conical, and spherical shells in only separate zones characterized by the greatest curvatures of the initial roughnesses, rather than over the whole surface. R.U.

N67-31652 Lockheed Missiles and Space Co., Palo Alto, Calif.
STRESS WAVES IN A VISCOPLASTIC MEDIUM
A. M. Skobeev [1967] 5 p refs Transl. into ENGLISH from Inzh. Zh. (USSR), no. 2, 1967 p 139–142

Consideration is given to plane stress wave propagation in an unbounded medium with nonlinear viscosity. Emphasis is on the effects caused by the nonlinearity in the viscosity, since perturbations may be propagated with a velocity different from the elastic velocity. In the mathematical solution to the problem motion is assumed to be almost self-similar everywhere; this is again possible only for a nonlinear viscosity. Equations of motion and continuity, as well as ordinary differential equations are derived as part of the mathematical solution. R.U.

N67-31653 Lockheed Missiles and Space Co., Palo Alto, Calif.
SOLUTION OF STRUCTURAL MECHANICS PROBLEMS BY THE PARTIAL RESPONSES METHOD (PRM)
V. S. Chuvikovskii, O. M. Palii, and V. E. Spiro [1966] 13 p refs Transl. into ENGLISH from Sudostroenie (Leningrad), no. 7, Jul. 1966 p 15–21

The partial responses method (PRM) is defined and illustrated for the numerical solution of one-dimensional boundary value problems of structural mechanics problems of shipbuilding. The solution is used to investigate general running vibrations, free-vibration modes and frequencies of a ship's hull, longitudinal and torsional vibrations of ship drive shafts, bending of ship's hull on docking, axisymmetric problems of shells of revolution. The PRM was developed on the basis of the method of successive reduction of elements of mechanical systems to inertialess elastic constraints. Specifically, the PRM deals with the method of expansion of the desired solution in eigenfunctions (method of principal coordinates) or its representation in integral form in terms of Green's function. R.U.

N67-31689*# Naval Research Lab., Washington, D. C. Shock and Vibration Information Center.
THE SHOCK AND VIBRATION BULLETIN 36, PART 7
Feb. 1967 173 p refs Presented at the 36th Symp. on Shock and Vibration, Los Angeles, 18–20 Oct. 1966; Sponsored by AF
(AD-651404) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ESTIMATE OF EFFECT OF SPACECRAFT VIBRATION QUALIFICATION TESTING ON RELIABILITY C. V. Stahle, Jr. (Martin Co.) p 1–8 refs (Se N67-31689 18-31)

2. S-IC RELIABILITY PROGRAM FOR STRUCTURAL LIFE VIEWPOINT R. L. Rich and J. A. Roberts (Boeing Co.) p 19–25 ref (See N67-31690 18-31)

3. STRUCTURAL RELIABILITY: PANEL SESSION W. H. Roberts et al (Martin Co.) p 27–40 (See N67-31691 18-32)

4. DYNAMIC ANALYSIS OF ATS-B SPACECRAFT S. M. Kaplan and V. Terkun p 41–62 refs (See N67-31692 18-31)

5. SPACECRAFT DESIGN FOR ATLAS TORSIONAL SHOCK TRANSIENT S. Davis (Republic Aviation Corp.) p 63–71 refs (See N67-31693 18-31)

6. COMPARISON OF PREDICTED AND MEASURED LAUNCH LOADS FOR SNAP 10A E. A. Robb and A. P. Gelman p 73–78 (See N67-31694 18-22)

7. GROUND-WIND-INDUCED OSCILLATIONS OF GEMINI-TITAN AIR VEHICLE AND ITS ERECTOR J. E. Tomassoni and W. H. Lambert (Martin Co.) p 79–88 (See N67-31695 18-31)

8. NOISE LEVEL MEASUREMENTS FOR IMPROVED DELTA, ATLAS/AGENA-D, AND TAT/AGENA-D LAUNCH VEHICLES L. A. Williams and W. B. Tereniak (NASA Goddard Space Flight Center) p 89–102 refs (See N67-31696 18-31)

9. THE "VACUUM SPRING" K. D. Robertson (Army Material Res. Agency) p 103–111 ref (See N67-31697 18-32)

10. SELF-ADAPTIVE VIBRATION BALANCING DEVICE FOR HELICOPTERS H. E. Hooper (Boeing Co.) p 113–127 refs (See N67-31698 18-32)

11. SHOCK RESPONSE OF ELECTRONIC EQUIPMENT CABINETS BY NORMAL MODE METHOD T. K. Hasselman and C. M. Hwang (TRW Sys.) p 129–134 refs (See N67-31699 18-32)

12. DAMPED VIBRATIONS OF ELASTICALLY SUPPORTED RIGID BODY WITH COUPLING BETWEEN TRANSLATION AND ROTATION F. H. Collopy (ITEK Corp.) p 135–144 refs (See N67-31700 18-32)

13. MISSILE HANDLING ANALYSIS C. R. Brown and A. J. Avis (Westinghouse Elec. Corp.) p 145–151 refs (See N67-31701 18-32)

N67-31691# Martin Co., Orlando, Fla.
STRUCTURAL RELIABILITY: PANEL SESSION
William H. Roberts et al *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 27–40 (See N67-31688 18-32)

A new approach to structural safety permits one to deal with margins appropriate to the probabilities contained in load and strength. The difference between load and strength is used as well as the variance. If comparable statements are made, one including error and one without, error is shown to be the dominant quantity. As to the ability to handle reliability analytically and to quantify reliability, the ordering of this new portion of the science will be done because it is so much cheaper to solve the problem analytically than by testing. The improvements required to reach extreme reliability will be determined from the analysis of where lie the gains capable of giving the needed improvements. Author

N67-31697# Army Materials Research Agency, Watertown, Mass.
THE "VACUUM SPRING"
K. D. Robertson *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 103–111 *ref* (See N67-31688 18-32)

A new nonlinear spring was developed which may satisfy both shock and vibration requirements simultaneously. This spring combines high energy absorption and vibration attenuation over a wide range of forcing frequencies. This unusual behavior is produced by a stepwise nonlinearity in its loading curve which is composed of two straight-line segments of differing slopes representing two independent spring rates. The slopes of these line segments and the point of intersection can be adjusted to suit any particular design requirements. A spring-mass system involving this concept has been simulated on an analog computer. Results indicate that it is possible to construct a suspension system which will not resonate at any frequency (under certain loading conditions) but will absorb large amounts of energy while remaining elastic. Author

N67-31698# Boeing Co., Morton, Pa.
SELF-ADAPTIVE VIBRATION BALANCING DEVICE FOR HELICOPTERS
W. Euan Hooper *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 113–127 refs (See N67-31688 18-32)

The device balances out the exciting forces at the point at which it is situated and keeps that point nodal in the presence of vibration emanating from any other point. It is self-adaptive to changes in excitation from zero to maximum and has a very rapid response time. Similarly, it adapts rapidly to changes in the rotor speed and in the phase of the excitation relative to the rotating system. The device takes its drive from the rotating system and is as light as an inertial balancing system can be. It requires no external power supplies in the form of hydraulics or electrics, and once installed would be sealed for life. The operating principles have been intensely investigated through theoretical and model means. Certain dynamic requirements of the mounting point, which correspond approximately to those of a supercritical shaft, have to be satisfied. The behavior of the device when accelerating through critical frequencies has been analyzed and tested, and the results of this work are summarized. Aspects of an installation in a helicopter are discussed and it is concluded that, for a modest expenditure in weight and mechanical complexity, the device can virtually eliminate helicopter n/rev vibration as an operational problem. Author

N67-31699# TRW Systems, Redondo Beach, Calif.
SHOCK RESPONSE OF ELECTRONIC EQUIPMENT CABINETS BY NORMAL MODE METHOD
T. K. Hasselman and C. M. Hwang *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 129–134 refs (See N67-31688 18-32)

The usefulness of the normal mode method for computing the dynamic shock response of base-excited cabinet-type structures is illustrated. The detailed dynamic loads which are obtained eliminate many of the uncertainties encountered in a load factor approach to the design problem. A structure can be analytically tested long before the hardware is available, which results in a more efficient development process. New configurations are particularly suited to the treatment. Several sonar system cabinets were analyzed which averaged 65 in. in height and weighed approximately 300 to 1200 lb. Excitation consisted of an acceleration pulse recorded during prior testing of similar equipment on the medium weight shock machine using the 25- to 30-cps simulated deck. Insight into the excitation-system-response relationship can be provided by examination of plotted mode shapes and a comparison of their corresponding frequencies with the frequency content of the excitation. Isometric representation and orthographic projection of overall maximum displacements help to focus attention on critical areas and indicate how certain load conditions arise. Author

N67-31700# Itek Corp., Lexington, Mass.
DAMPED VIBRATIONS OF ELASTICALLY SUPPORTED RIGID BODY WITH COUPLING BETWEEN TRANSLATION AND ROTATION
Francis H. Collopy *In* NRL, Washington Shock and Vibration Bull. 36, Pt. 7 Feb. 1967 p 135–144 refs (See N67-31688 18-32)

A solution to the damped system for a certain range of dimensionless parameters and a description of the means for future analytical extensions are presented. Ground displacement and rotation are considered for the forced vibration condition, and graphs

are presented for the dimensionless rotational amplitude ratios, and of the rotational amplitude ratios at uncoupled rotational frequencies. It is concluded that the curves illustrate the interdependence of mass, mass moment of inertia, translational and rotational spring rates and damping constants, and the distance between the center of gravity of the system and the excitation. N.E.N.

N67-31701# Westinghouse Electric Corp., Sunnyvale, Calif.
MISSILE HANDLING ANALYSIS
C. R. Brown and Alex J. Avis *In* NRL, Washington Shock and Vibration Bull. 38, Pt. 7 Feb. 1967 p 145–151 refs (See N67-31688 18-32)

The handling of Polaris missiles from submarine tenders to submarines was studied by analyses and full-scale tests. Results are given of a rigid body shock analysis and of loading tests at a selected harbor and at the San Francisco Bay Naval Shipyard. The test results indicate that the existing Polaris loading fixture without shock absorbers will protect the missile up to a vertical impact velocity of 0.7 to 1.0 fps. With shock absorbers, the system operates safely up to about 4.0 fps. An alternate system, which automatically controls the position of the loading fixture relative to the submarine deck, is also discussed. This system, called Yo-Yo, provides negligible impact or lift-off velocities. A model Yo-Yo unit was tested, and good operating characteristics were noted. It is concluded that the shock loading problem can be eliminated by using either shock absorbers or a constant relationship crane system. A shock absorber system was selected for Poseidon handling system. Author

N67-31716*# Wyle Labs., Huntsville, Ala. Testing Div.
JOINT ACCEPTANCE FOR CYLINDERS
A. R. Wenzel Jun. 1967 28 p refs
(Contract NAS8-5384)
(NASA-CR-85977; WR-67-9) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A theoretical analysis of the response of a thin cylindrical shell to a random loading is given, and equations defining the joint acceptance of a cylinder are derived. The governing equations of motion are taken to be the Reissner shallow shell equations. The solution gives the spectral density function of both the radial displacement and stress function in terms of the normal modes of the cylinder and the spectral density function of the external pressure field. The final equations involve an external pressure-structural mode coupling term similar to the joint acceptance as defined by Powell, which then serves as the basis for defining the joint acceptance for cylinders. Using these equations, numerical results are obtained for the joint acceptance for a cylinder in a diffuse sound field. Author

N67-31737* Harvard Univ., Cambridge, Mass.
NOTES ON NON-LINEAR SHELL THEORY
Bernard Budiansky Jul. 1967 31 p refs
(Grant NsG-559; Contract Nonr-1866(02))
(NASA-CR-86656; SM-14) CSCL 20K

Exact tensor equations of equilibrium are derived for non-linear membrane shell theory and small perturbations of pressurized membrane shells. Approximate equations (for sufficiently small initial strains and rotations) for small perturbations of pressurized membrane shells are also given. Exact equations for the general non-linear shell theory (including bending) are discussed, and approximate equations (again for small initial strains and rotations) are derived for the small perturbations, buckling, and vibration of stressed shells. Author

N67-31785 Lockheed Missiles and Space Co., Palo Alto, Calif.
CARRYING CAPACITY OF SMOOTH AND REINFORCED CYLINDRICAL SHELLS
I. T. Vokhmianin and Iu. V. Nemirovskii [1967] 6 p refs Transl. into ENGLISH from Prikl. Mekhan. i Tekhn. Fiz. (USSR), v. 3, no. 1, 1967 p 18–23

Consideration is given to the problem of the loading capacity of smooth and ring-reinforced cylindrical shells, clamped along the edges and loaded by internal uniformly distributed pressure. An exact solution to the problem is obtained with the help of the concept of a rigidly ideal plastic material subject to the Tresk plasticity condition. For a two-layered shell, the calculated values of the ultimate loading are compared with the Hodge solution. R.U.

N67-31805# Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE QUESTION OF MEMBRANE DEFORMATION
O. G. Korol' [1966] 3 p refs Transl. into ENGLISH from Samoletstr. i Tekhn. Vozdushn. Flota (USSR), no. 7, 1966 p 112–114

A theoretical investigation of the membrane deformation process using engineering techniques of analysis is presented. Both the tensile and the bending deformation are considered. It is assumed that the normals remain plane during deformation, and this assumption is confirmed experimentally. Equations are derived to determine the radial velocity component, and the axial velocity component. A diagram of the deformation of a membrane, for a general case, is presented. It is considered that the formulas given are relatively simple and may be used successfully in engineering computations of metal plastic deformation processes. R.U.

N67-31821*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
STRUCTURAL MECHANICS OF DEFORMATION AND FRACTURE Quarterly Progress Report
I. J. Gruntfest Mar. 1967 31 p refs Submitted for publication
(Contract NASw-1190)
(NASA-CR-86554; QPR-7) CSCL 20K

The quasi-static, adiabatic responses of an ideal viscous material are examined under conditions of cyclic and random loading and straining. The heating due to work done against viscosity affects the coefficient of viscosity which is governed by an activation energy. This non-linear effect is shown to result in theoretical behavior qualitatively similar to published experimental data. Comparison is made between an exponential type of temperature–viscosity relationship and the relationship governed by the energy of activation concept. Author

N67-31838 Lockheed Missiles and Space Co., Palo Alto, Calif.
EXPERIMENTAL INVESTIGATION OF THE DISTRIBUTION OF IMPULSE MAGNITUDES ON THE WALLS OF CYLINDRICAL SHELLS WITH INSTANTANEOUS ENERGY LIBERATION
V. G. Dorofeev, E. A. Limberg, L. V. Litovskii, O. F. Tkachev, and Iu. V. Iakovlev [1966] 5 p refs Transl. into ENGLISH from Samoletostr. i Tekhn. Vozdukh. Flota (USSR), no. 7, 1966 p 89–93

Absolute values of the total specific impulses and the specific shock impulses on the walls of cylindrical shells submerged in a fluid in which energy was liberated instantaneously, were measured. The nature of the impulse distribution on the shell walls was also studied. The measuring apparatus used is depicted and described. An analysis of the constructed diagrams for the distributions of total and shock impulse shows that the fraction of the shock impulse in the total specific impulse increases as the energy from the energy carrier increases. L.S.

N67-31977 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE KINETICS OF CRACK PROPAGATION, FRACTURE CONDITION AND PROLONGED STRENGTH
G. I. Barenblatt, V. M. Entov, and R. L. Salganik 21 Jun. 1966 8 p refs Transl. into ENGLISH from Inzh. Zh.: Mekh. Tverdogo Tela (Moscow), no. 6, 1966 p 76–80

A general approach to the investigation of crack propagation in materials with time-dependent (relaxing and fracturing) relations is formulated; primarily polymers are kept in mind. A general formulation of the problem of crack theory is discussed, conditions are formulated for the brittle fracture of solids from such materials, and in connection with the conceptions developed, some questions of prolonged strength are examined. Author

N67-31994 Lockheed Missiles and Space Co., Palo Alto, Calif.
ON THE KINETICS OF CRACK PROPAGATION. REMARK ON THE RULE OF SUMMATION OF DAMAGE
G. I. Barenblatt, V. M. Entov, and R. L. Salganik [1967] 4 p refs Transl. into ENGLISH from Inzh. Zh. (USSR), no. 2, 1967 p 148–150

In an investigation of the kinetics of crack propagation, consideration is given to the rule of summation of damage for prolonged strength with time-varying stress. The propagation of a rectilinear crack in an infinite body loaded at infinity by a time-dependent stretching stretch, perpendicular to the direction of crack propagation is considered. The rule of summations of a damage follows from the general approach developed under the assumption of the formula for the longevity under the effect of constant loading. R.Ll.

N67-31995 Lockheed Missiles and Space Co., Palo Alto, Calif.
EXPERIMENTAL STUDY OF THE STABILITY OF A ROD COMPRESSED BY A FOLLOWING FORCE
Iu. I. Iagn and L. K. Parshin [1967] 4 p refs Transl. into ENGLISH from Tr. Leningr. Politekhn. Inst. (Moscow), no. 278, 1967 p 52–54

Stability analyses of structures subject to nonconservative forces are reviewed. An apparatus for the experimental study is described. Graphs depict the resistance during deflections from the equilibrium position, as well as the linear and angular displacements of the end of the rod during vibration in the post-critical state. The noticeable lag in the phase of the rotational motion of the end of the rod from the phase of its linear displacements should be noted. R.Ll.

N67-32116*# IIT Research Inst., Chicago, Ill. Fluid Dynamics Sect.
STUDY OF VIBRATIONS INDUCED IN THIN-WALLED PIPES UNDER VARYING FLOW CONDITIONS Final Report
J. M. Clinch Jun. 1967 129 p refs
(Contract NAS8-20325)
(NASA-CR-86659) CFSTI: HC$3.00/MF$0.65 CSCL 20K

Vibrations induced in thin-walled cylindrical pipes by the passage of internal turbulent water flow were investigated. A theoretical analysis based on the application of random vibration theory was developed for predicting the vibrational response of thin-walled pipes to the turbulent wall pressure field at high mode orders and frequencies. A continuously operating water flow facility capable of producing Reynolds numbers of 2×10^6 was designed and constructed. The noise levels in this facility were reduced to values commensurate with the measurement of the turbulent wall pressure fluctuations in a long cylindrical pipe section. Wall-mounted miniature pressure transducers were fabricated to record the wall pressure fluctuations in turbulent pipe flow. The data obtained from these measurements and also from determining the pipe damping factor were used in calculating the pipe wall response to turbulent flow excitation. Measurements of the vibrational response to fully-developed turbulent flow of a thin-walled pipe in 1/3-octave bands showed very good agreement with the predicted values of the response over a wide range of flow speeds and exciting frequencies. Author

N67-32122*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF VARIOUS OPTICAL RADIATIONS AND WATER VAPOR ON TRAPPING SPECTRUM OF CADMIUM SULFIDE
Paul A. Faeth Washington, NASA, Jul. 1967 18 p refs
(NASA-TN-D-3974) CFSTI: HC$3.00/MF$0.65 CSCL 20L

Trapping levels in a single cadmium sulfide crystal were studied by the thermally stimulated current method. In all, six trapping levels were detected in the crystal. A study of the shallow traps, which occurred at 0.04, 0.12, and 0.13 electron volt below the conduction band edge, indicated that these traps could be filled preferentially by matching the photon energy to the energy height of the trap above the valence band edge. Also, filled traps could be emptied by light with sufficient energy per photon. Cooling of the crystal during illumination with white light populated a previously unreported trapping level. Water vapor which was adsorbed on the crystal surface produced a thermally stimulated current at 80° to 100°C in the absence of any treatment of the crystal by light. This peak was ascribed to the break up of water ions on the crystal surface. Pumping on the crystal with adsorbed water present also stimulated currents believed due to desorption of water ions. Author

N67-32131# Boeing Co., Seattle, Wash. Solid State Physics Lab.
A SCATTERED LIGHT PHOTOELASTIC METHOD FOR THE DETERMINATION OF TEMPERED STRESSES IN AIRCRAFT WINDSHIELDS
Y. F. Cheng Apr. 1967 24 p refs Submitted for publication
(D1-82-0606; AD-652416) CFSTI: HC$3.00/MF$0.65

Numerous attempts have been made in the past to determine nondestructively the stresses in tempered glass plates. A brief review is given of earlier methods, which only determine the surface stress or the stress at the middle plane, and a new scattered light photoelastic technique is described for determining the stress distribution across the thickness of tempered glass plates. The theory of this new method is developed, and experimental apparatus as well as techniques are described. Experiments were made with an aircraft windshield sample having a three-layer (glass-vinyl-glass) sandwich structure. Photographs of fringe patterns in scattered light are shown and the stress distribution across the thickness of the glass layer is determined. Author (TAB)

N67-32137*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL INVESTIGATION OF THE TRANSONIC FLUTTER OF SIMPLE THIN TRUNCATED-CONE PANELS
Jean Gilman, Jr. Washington, NASA, Oct. 1961 36 p refs
(NASA-TM-X-599) CFSTI: HC$3.00/MF$0.65 CSCL 20K
(Declassified)

The panels had length-to-thickness ratios of about 2,400 and 1,200 and were tested in a nonuniform flow field. When the pressure in the compartment behind the panel was reduced sufficiently below the maximum pressure to cause buckling, the panels experienced random vibrations or fluttered. The reduction in compartment pressure below maximum external pressure required to destabilize the panels became greater as the panel thickness or dynamic pressure was increased. Neither random vibrations nor flutter were immediately destructive. Author

N67-32158* North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.
STUDY OF THE DYNAMIC RESPONSE OF ELASTIC SPACE STATIONS. VOLUME III: COMPUTER PROGRAMS Final Report
Paul C. Kamrath Jun. 1966 320 p
(Contract NAS7-338)
(NASA-CR-66445; SID-66-426-3) CSCL 20K

Five computer programs, written in the Fortran IV language, were developed to compute the dynamic response characteristics of two large elastic space stations: the Y-configuration and the hexagonal configuration. These programs are primarily intended for study of the response characteristics of the spinning flexible space stations following the docking of another vehicle at the central hub. The modal programs compute the in-plane and normal-to-plane symmetric and antisymmetric normal modes of free vibration of the non-rotating space stations. The response program computes the time history of motion of the space stations from the linearized equations of motion, and employs the normal modes to define the elastic degrees of freedom. Time histories of the six rigid-body coordinates and the distributed modal coordinates (twelve maximum) are computed by using a fourth-order Runge–Kutta integration routine. The computer programs have been written with sufficient generality to permit an arbitrary choice of dimensional, structural, and inertial properties of the configurations. Listings of the program source decks and example data decks, and execution printout of an example case for each program are contained herein. Author

N67-32160* North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.

STUDY OF THE DYNAMIC RESPONSE OF ELASTIC SPACE STATIONS. VOLUME II: COMPUTER PROGRAM DESCRIPTIONS Final Report

Paul C. Kamrath and Russell B. Jorgensen Jun. 1966 136 p

(Contract NAS7-338)

(NASA-CR-66444; SID-66-426-2) CSCL 20K

An analytical procedure and five computer programs, written in the Fortran IV language, were developed to compute the dynamic response characteristics of two large elastic space stations: the Y configuration and the hexagonal configuration. These programs are primarily intended for study of the response characteristics of the spinning flexible space stations following the docking of another vehicle at the central hub. The modal programs compute the in-plane and normal-to-plane normal modes of free vibration of the non-rotating space stations. The response program computes the time history of motion of the space stations from the linearized equations of motion, and employs the normal modes to define the elastic degrees of freedom. Inertia coupling between the in-plane and normal-to-plane symmetric and antisymmetric motions is taken into account. A linearized gyroscopic wobble damper which is located at the central hub is included in the analysis. Time histories of the six rigid-body coordinates and the distributed modal coordinates (twelve maximum) are computed by using a fourth-order Runge–Kutta integration routine. The computer programs have been written with sufficient generality to permit an arbitrary choice of dimensional, structural, and inertial properties for the configurations. Operating instructions, assumptions and limitations, input and output descriptions, and program descriptions are contained herein. Author

N67-32176 Lockheed Missiles and Space Co., Palo Alto, Calif.

APPLICATION OF THE NEUMANN–PEARSON–WALD STATISTICAL HYPOTHESES IN SOME STRUCTURAL MECHANICS PROBLEMS

V. M. Goncharenko [1967] 7 p refs Transl. into ENGLISH from Prikl. Mekh. (Kiev), v. 3, no. 4, 1967 p 111–116 Presented at the All-Union Conf. on Appl. of Probability and Reliability Theory Methods in Structural Mech., Moscow, Nov. 1965

The question of finding the reliability of a structure whose state depends on a set of stochastic variables is considered. It is not the distribution function of these variables which is considered known, as is usually assumed, but the final sampling of their values. The problem is to apply the theory of testing statistical hypotheses by utilizing Wald's sequential analysis. The proposed method is illustrated by an example. Author

N67-32284 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NON-STATIONARY PROBLEMS OF THERMOELASTICITY FOR A PLATE AND A CYLINDRICAL SHELL

V. F. Kolesov *In its* J. of Eng. Phys. 17 Mar. 1967 p 19–27 refs (See N67-32281 18-34)

Solution of nonstationary dynamic problems of thermoelasticity is given for a circular cylindrical shell of finite length and for a circular plate with a central hole. Through the thickness of the plate and the shell the temperature is distributed uniformly; along the height of the shell and radius of the plate temperature is distributed according to a parabolic law. Author

N67-32353*# Pennsylvania Univ., Philadelphia. School of Chemical Engineering.

APPLICATION OF COMPUTER TECHNIQUES TO SOME PROBLEMS IN LINEAR VISCOELASTICITY

Joseph W. Sell and William C. Forsman 21 Jun. 1967 126 p refs

(Grant NsG-667)

(NASA-CR-86982) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The effect on calculated viscoelastic functions of gradually introducing entanglement coupling in the Williams, Landel, and Ferry (WLF) modification of Rouse's theory of viscoelasticity is examined. An empirical equation is proposed that makes the segmental friction factor a function of the molecular weight and the critical chain length between entanglement points. Data are used to test the validity of a number of approximate equations for the interconversion of the various viscoelastic functions in regions where the relaxation spectrum has a slope of about $-1/2$ on a log–log plot. Where the relaxation spectrum exhibits a plateau region, a number of the interconversion equations gave poor approximations. None of the interconversion equations are applicable in regions where the relaxation spectrum is discrete. Author

N67-32382*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

STRUCTURAL EFFICIENCY OF RING-STIFFENED CORRUGATED CYLINDERS IN AXIAL COMPRESSION

James P. Peterson Washington, NASA, Aug. 1967 30 p refs

(NASA-TN-D-4073) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Results of an analytical study of desirable proportions of corrugated ring-stiffened cylinders are presented. The corrugated walls of the cylinders studied consisted of narrow, equal thickness, flat elements joined along longitudinal edges. The rings could have any of a wide range of cross-sectional geometries and could be fastened to either the inside or the outside surface of the cylinder wall. The study indicates that the corrugated wall should be constructed of elements which have width-thickness ratios as large as possible without introducing local buckling of the elements; the wall should be formed with angles between adjacent elements of approximately 120° ($\phi = 60°$). The study of cylinders with internal stiffening indicates that unsymmetrical rings (T-section) are preferable to symmetrical rings (I-section), and that the rings should have a mass of approximately 30% of that of the corrugated wall. For externally stiffened cylinders, ring shape and ring spacing are found to be relatively unimportant, but ring area is again important. Author

N67-32467# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.

A NUMERICAL SOLUTION FOR LONGITUDINAL WAVES IN A CYLINDRICAL SHELL

R. B. Testa Apr. 1967 16 p refs

(Contract Nonr-266(36))

(TR-41; ONR-266(86)-CE; AD-653115) CFSTI: HC $3.00/MF $0.65

An explicit and rapidly convergent numerical scheme is presented for the solution of the longitudinal impact of a cylindrical, elastic, membrane shell. The response previously obtained by another numerical procedure is reproduced with much shorter computation times, and the numerical solution is extended to larger values of time after impact. Author (TAB)

N67-32640# Army Materials Research Agency, Watertown, Mass.
APPROXIMATIONS IN NONSYMMETRIC SHELL VIBRATIONS
Edward W. Ross, Jr. Apr. 1967 35 p refs
(AMRA-TR-67-09; AD-652255) CFSTI: HC $3.00/MF $0.65

The nonsymmetric vibration of shells of revolution is studied by means of classical thin-shell theory. Approximations are found by asymptotic methods for the eight solutions of the system. The behavior of the solutions when the frequency becomes either large or small is discussed. The approximations are used to give general descriptions of the types of natural frequencies and modes that can be found. In particular, the occurrence of very low natural frequencies associated with inextensional modes is shown to be impossible in many cases. Author (TAB)

N67-32667# Naval Civil Engineering Lab., Port Hueneme, Calif.
WINDOWS FOR EXTERNAL OR INTERNAL HYDROSTATIC PRESSURE VESSELS. PART II. FLAT ACRYLIC WINDOWS UNDER SHORT-TERM PRESSURE APPLICATION
J. D. Stachiw, G. M. Dunn, and K. O. Gray May 1967 84 p refs
(NCEL-TR-527; AD-652343) CFSTI: HC $3.00/MF $0.65

Flat, disk-shaped acrylic windows of different thickness-to-diameter ratios have been tested to destruction under short-term hydrostatic loading at room temperatures, where short-term loading is defined as pressurizing the window hydrostatically on its high-pressure face at a 650-psi/minute rate till failure of the window takes place. Critical pressures and displacements of windows with thickness to effective diameter ratios less than 1.0 have been recorded and plotted. The critical pressures derived from testing flat windows in flanges with 1.5-inch, 3.3-inch, and 4.0-inch openings have been found applicable also to flanges with larger openings, so long as the larger windows are of the same t/D sub i and D sub o/D sub i ratios, where t is thickness of the window, D sub i is the clear opening in the flange and therefore the effective diameter of the window exposed to ambient atmospheric pressure and D sub o is overall diameter of the window face exposed to hydrostatic pressure. The performance of flat windows under short-term hydrostatic pressure has been found to be comparable to that of conical windows with included angle equal to, or larger than 90 degrees. Author (TAB)

N67-32678 Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
A LAMINATED THIN CYLINDRICAL SHELL UNDER AXISYMMETRIC STATIC LOADING
W. R. Spillers Apr. 1967 27 p refs
(Contract Nonr-266(78))
(TR-39; AD-652360) CFSTI: HC $3.00/MF $0.65

A model is used to discuss the behavior of a laminated shell in which the laminating mechanism is represented by springs which allow both separation and relative layeral motion or slip of the faces of the homogeneous isotropic layers. By varying the spring constants it is possible to determine the dependence of both the buckling load and the flaxural response upon a wide range of conditions. It is the attempt here to use the most simple model possible which has physical relevance. Author (TAB)

N67-32687# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
THE EFFECT OF COUPLE-STRESSES ON THE CORNER SINGULARITY DUE TO AN ASYMMETRIC SHEAR LOADING
David B. Bogy and Eli Sternberg Apr. 1967 34 p refs
(Contract Nonr-220(58))
(TR-11; AD-652372) CFSTI: HC $3.00/MF $0.65

The plane-strain problem of an orthogonal elastic wedge, one face of which is subjected to arbitrary shearing tractions in the absence of other loads, is treated both within classical elastostatics and within a linear theory of elastic behavior that takes into account the influence of couple-stresses. If the loading fails to vanish at the apex, the conventional theory gives rise to corner singularities in the stress and rotation field, which stem from the incompatibility of the assumed boundary conditions with the symmetry of the stress tensor. These singularities are determined in closed elementary form and are found to agree with earlier results due to E. Reissner for the case of a uniform shear loading. It is shown next that the foregoing singularities disappear according to the couple-stress theory, in which the stress tensor is no longer required to be symmetric. Author (TAB)

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-31523 Royal Aircraft Establishment, Farnborough (England).
THE APPLICATION OF SURFACE TEMPERATURE MEASUREMENT TECHNIQUES TO THERMAL INSULATORS. A LITERATURE SURVEY
D. Purslow London, Min. of Aviation, Sep. 1963 23 p refs
(RAE-TN-STRUCT-340)

This survey describes existing methods and techniques which might find an application in the measurement of the surface temperature of thermal insulators under transient, radiant heat inputs. These methods include thermocouples, resistance thermometers, radiation pyrometers, paints, thermography and infra-red photography. Severe limitations are to be expected to all the methods as described. The survey should therefore be used only as the basis for further development commencing, possible, with thin film or fine wire thermocouples. Author

N67-31524*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SOME OBSERVATIONS OF BASE HEATING AT MACH 3.0 ON A SIMULATED MISSILE WITH JP-4 LIQUID-OXYGEN ROCKET
Nick E. Samanich, J. Calvin Lovell, and Donald O. Barnett Washington, NASA, Nov. 1960 22 p refs
(NASA-TM-X-411) CSCL 16D (Declassified)

At Mach 3.0 and a simulated pressure altitude of 73,000 feet, base temperatures, heat flux, and pressures were measured at chamber pressures of 425 to 600 lb/sq in. abs and oxidant-to-fuel ratios of 1.7 to 2.65. During some of the firings, combustion of entrained fuel-rich exhaust gases in the missile base region was encountered. Gas temperatures varied from about 1100° without a fire to 2600°R with a base fire. Base fires occurred at oxidant-to-fuel ratios of 2.3 and higher and heated the base almost entirely by convection. Author

N67-31532*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL BEHAVIOR OF COMBUSTION PRODUCTS OF HEF-2 AND AIR DURING EXPANSION IN EXHAUST NOZZLES
J. R. Branstetter, W. B. Kaufman, and A. L. Smith Washington, NASA, Dec. 1960 61 p refs
(NASA-TM-X-381) CSCL 21B (Declassified)

The performance of HEF-2 (largely propylpentaborane) combustion products was investigated in exhaust nozzles with 4- and 12-inch/diameter throats. Specific-fuel-consumption data agreed well with ideal values (assuming B_2O_3 as the only boron combustion product) when the B_2O_3 was either completely liquid or completely vapor. In the two-phase region (3200° to 3500°R) the fuel consumption was 11 percent to 20 percent higher than the ideal. However, when the vaporized combustion product was assumed to be HBO_2 rather than B_2O_3, the ideal values for a frozen-expansion process agreed very well with the test data. No effect of combustor or nozzle size on performance was observed. Author

N67-31710# Los Alamos Scientific Lab., N. Mex.
THE HOT-WIRE IGNITION OF SECONDARY EXPLOSIVES IN SQUIBS
Robert J. Reithel 29 Mar. 1967 23 p refs
(Contract W-7405-ENG-36)
(LA-3668) CFSTI: HC $3.00/MF $0.65

Electrically heated platinum bridgewires were used to ignite secondary explosives in pressure cartridges. These cartridges, containing only RDX or HMX, were ignited at currents ranging from a fraction of 1 to over 50 A in times ranging from less than 1 msec to more than 1 sec. HMX-loaded cartridges functioned after being subjected to a temperature of 190°C for many hours. When subjected to rapid heating, these pressure cartridges did not undergo autoignition until reaching 240°C. The safe current, i.e., that current to which the bridgewire may be subjected for 1 min without igniting the explosive, of these pressure cartridges may be adjusted to values as large as 10 A by an appropriate choice of the bridgewire diameter. The pressure cartridges may be converted to detonators by using the evolved gases to drive a flying plate against a second charge of secondary explosive. Author (NSA)

N67-31724*# Little (Arthur D.), Inc., Cambridge, Mass.
[TASKS 1 AND 2] Monthly Progress Report, 3 Apr.–3 May 1967
10 May 1967 11 p
(Contract NAS3-7974)
(NASA-CR-85856; MPR-4) CSCL 20M

As part of a program to develop an insulation system for a liquid nitrogen tank, a multilayer insulation was fabricated onto a calorimeter tank. The system consists of 10 doubly aluminized polyester shields and 11 spacers, each consisting of two layers of silk netting. Three tests were performed with this system. The first test lasted 90 hours, during which all chamber baffles were maintained at 80°F and an average flux of 0.27 Btu/hr ft^2 was measured. The second test lasted 32 hours, with the upper baffle at −318°F and the lower baffle remaining at 80°F, and a heat flow rate of 3.8 Btu/hr was measured from which a flux of 0.20 Btu/hr ft^2 for the lower half of the insulation system was computed. During the third test all baffles were maintained at −318°F, and a heat flow rate of 0.2 Btu/hr was measured in the system. Tabulated results are presented of calorimeter conditions, heat flow, and insulation heat flux. Briefly mentioned is also progress in the modification of a thermal computer model for pipe penetration, and emittance measurements conducted with the material used for radiation shields in the insulation system. K.W.

N67-31730*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL BEHAVIOR OF PENTABORANE–AIR COMBUSTION PRODUCTS DURING EXPANSION IN A CONVERGENT DIVERGENT NOZZLE
J. Robert Branstetter and Paul C. Setze Washington, NASA, 18 Feb. 1958 69 p refs
(NACA-RM-E57120) CFSTI: HC $3.00/MF $0.65 CSCL 21E
(Declassified)

Pentaborane–air mixtures, burned to completion at a pressure of 3 atmospheres, were expanded through a 7.1-inch-long nozzle having a 4-inch-diameter throat. The thrust performance agreed well with the ideal equilibrium performance at stagnation temperatures up to 3300°R. In the combustor, the boric oxide failed to condense unless supercooled about 400°F. For a given thrust, fuel consumption was as much as 20 percent greater than predicted from vapor-pressure data for combustor-outlet temperatures near 3600°R. Condensation was observed only in the subsonic portion of the nozzle. Friction, due to liquid boric oxide films on the nozzle surface, was negligible when the surface temperature was above 800°F. Author

N67-31731*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL INVESTIGATION OF BASE HEATING AND ROCKET HINGE MOMENTS FOR A SIMULATED MISSILE THROUGH A MACH NUMBER RANGE OF 0.8 TO 2.0
Bruce G. Chiccine, Alfred S. Yalerino, and Arthur M. Shinn Washington, NASA, Oct. 1959 29 p refs
(NASA-TM-X-82) CFSTI: HC $3.00/MF $0.65 CSCL 16D
(Declassified)

The effects of jet and stream interactions were investigated with a 1/13-scale ballistic missile using a liquid oxygen–JP-4 fuel rocket. Nozzle extension ratios were studied at angles of attack of 0° and 5° with 0° and 4° motor gimbal angles and several combustion chamber pressures over the Mach number range. Base region temperatures were reduced from as high as 1200°F to tunnel stagnation values by increasing the rocket extension from 0.32 to 0.78 body diameter. Aerodynamic hinge moments were generally found to decrease with decreasing nozzle extension, flight Mach number, and increasing jet pressure ratio. Author

N67-31858*# National Aeronautics and Space Administration, Washington, D. C.
THE LAMINAR BOUNDARY LAYER IN A RADIATING-ABSORBING GAS NEAR A FLAT PLATE [LAMINARNYY POGRANICHNYY SLOY V IZLUCHAYUSCHE-POGLOSHCHAYUSHCHEM GAZE OKOLO PLOSKOY PLASTINKI]
V. P. Zamurayev Dec. 1965 14 p refs Transl. into ENGLISH from Zh. Prik. Mekhan. i Techn. Fiz. (Moscow), no. 3, 1964 p 73–80
(NASA-TT-F-411) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The steady state problem of the laminar flow of a radiating–absorbing gas in the boundary layer near a flat plate was studied. The asymptotic behavior of heat transfer far away from the tip of the plate is considered. A difference method of solving a system of partial differential equations with a complex integrodifferential energy equation is used to solve the problem over the entire length of the plate. In its basic features, the method employed is similar to the difference method used to solve boundary layer equations without regard for radiation. The paper concludes with a discussion of results obtained from a specific case considered in the analysis of the steady state laminar boundary layer near a flat plate. The character of heat transfer and the possibility of specifying radiation in the radiant heat conduction approximation are investigated. S.C.W.

N67-32003# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
[AEROSPACE TECHNOLOGY RESEARCH REPORT]
R. P. Bobco and R. H. Edwards Dec. 1966 49 p refs
(SSD-60571R; Rept.-21)

CONTENTS:

1. RADIATION FROM AN ABSORBING SCATTERING CONICAL DISPERSION WITH NON-UNIFORM DENSITY p 1–39 refs (See N67-32004 18-33)

2. APPLICATION TO A CONICAL DISPERSION OF ALUMINA PARTICLES R. P. Bobco p 41–48 refs (See N67-32005 18-33)

N67-32004# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
RADIATION FROM AN ABSORBING SCATTERING CONICAL DISPERSION WITH NON-UNIFORM DENSITY
In its Aerospace Technol. Res. Rept. Dec. 1966 p 1–39 refs (See N67-32003 18-33)

The integro-differential equation of radiative transfer is solved to a second order of approximation for an isothermal dispersion of absorbing, isotropically scattering particles confined by conical boundaries. The particle number density is assumed to vary inversely with the square of the distance from the cone vertex, a condition which approximates the distribution in a solid propellant rocket exhaust. A sequence of transformations is used to obtain an essentially closed-form second order solution for local, monochromatic, directional emissivity from the cone boundary. Numerical results are presented to show the influence on emissivity of cone angle, albedok and optical thickness. N.E.N.

N67-32005# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
APPLICATION TO A CONICAL DISPERSION OF ALUMINA PARTICLES
R. P. Bobco *In its* Aerospace Technol. Res. Rept. Dec. 1966 p 41–48 refs (See N67-32003 18-33)

Some insight to the magnitude of emission from alumina particles in a rocket engine exhaust is obtained using the second order solution derived in the text. Data previously reported are used to compute the extinction coefficient, albedo, and darkness factor. The data are based on spectral measurements of the real and imaginary parts of the complex index of refraction of Al_2O_3 at elevated temperatures. The index of refraction data is used in Mie scattering computations for a population of particles with a statistical mean size to obtain spectral absorption, scattering, and extinction cross sections. These data, together with results of a parametric study of Mie scattering are used to compute mean values of the extinction coefficient and albedo. The computations are summarized. Author

N67-32089*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LAMINAR FLOW ANALYSIS OF FILM BOILING FROM A HORIZONTAL WIRE
Kenneth J. Baumeister and Thomas D. Hamill Washington, NASA, Jul. 1967 46 p refs
(NASA-TN-D-4035) CFSTI: HC $3.00/MF $0.65 CSCL 20M

The heat-transfer coefficient for pool film boiling from a horizontal wire was analyzed by subdividing the wire into many cells and analyzing the behavior of a particular cell. A cell consists of a vapor dome and the thin annular film around it, and is assumed to be a time-averaged configuration of the actual situation in which vapor domes are growing and vapor is escaping. If it is assumed that the steady state equations can be applied to the time-averaged configuration, the Navier–Stokes equations with inertia terms neglected, the continuity equation, and the energy equation with convective terms neglected can be solved simultaneously to obtain the heat-transfer coefficient for horizontal wires in film boiling. Also, the cell size was assumed to adjust itself to maximize the rate of heat transport. Author

N67-32112*# Aerojet-General Corp., Downey, Calif. Research Div.
EVALUATION OF THE BLAST PARAMETERS AND FIREBALL CHARACTERISTICS OF LIQUID OXYGEN/LIQUID HYDROGEN PROPELLANT Final Report
R. E. Pesante and M. Nishibayashi 7 Apr. 1967 138 p refs
(Contract NAS9-4355)
(NASA-CR-65651; Rept.-0954-01(01)FP) CSCL 21B

The basic parameters of liquid oxygen/liquid hydrogen propellant are examined, the blast characteristics are compared with LOX/RP-1 and nitrogen tetroxide/Aerozine-50 propellant systems. Specific characteristics considered in evaluating the propellant systems were peak overpressure, shock wave velocity, positive pressure impulse and duration, fragment velocity, thermal radiation and temperature, initial fireball growth rate, and fireball size and duration. Cryogenic and hypergolic propellants were tested to evaluate the explosive and thermal characteristics. The overpressure tests indicated that the explosive yield of LOX/LH_2 increased as the distance from the event increased. Analysis of test films revealed that most of the fireball's growth occurred during the first 20 msec after propellant initiation. Examination of the initial fireball growth rate data from test to test indicated a similarity of growth rates for the LOX/LH_2 propellant. The maximum fireball diameters varied from 64 to 91 ft and the maximum height ranged from 38.5 to 73 ft. S.P.

N67-32282 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF PROCESS OF EVACUATION OF A GAS VOLUME
N. P. Belik, N. M. Belyayev, and G. S. Shandorov *In its* J. of Eng. Phys. 17 Mar. 1967 p 1–8 refs (See N67-32281 18-34)

A calculation method for the evacuation process of a gas volume is proposed. It is based on application of thermodynamic equations for variable mass bodies and assumptions of temperature constancy of internal surface of the volume and transfer of heat from this surface to the gas by free convection. Author

N67-32283 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
HEAT EXCHANGE BETWEEN A MOVING DISPERSED MEDIUM AND THE WALL OF A PIPE
V. I. Malyukevich *In its* J. of Eng. Phys. 17 Mar. 1967 p 9–17 refs (See N67-32281 18-34)

Experimental and theoretical investigations were conducted of local values of heat exchange for a moving, dense layer of loose dispersed medium with the wall in vertical cylindrical pipes. Author

N67-32286 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOLUTION OF NON-HOMOGENEOUS EQUATION OF THERMAL CONDUCTION FOR MULTILAYERED BODIES
P. Ye. Bulavin and V. M. Keshcheyev *In its* J. of Eng. Phys. 17 Mar. 1967 p 29–37 refs (See N67-32281 18-34)

A method of separation of variables is used to solve a one-dimensional nonstationary equation of thermal conduction with arbitrary heat sources and arbitrary law of temperature change of the medium in time for multi-layered symmetrical bodies (plate, cylinder, and sphere). Author

N67-32349# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

LOCATION OF THE BURNING ZONE IN THE INITIAL PART OF THE FLAME TUBES OF GTE CHAMBERS [RASPOLOZHENIYE ZONY GORENIYA V NACHAL'NOY CHASTI ZKAROVYKH TRUB KAMER GTD]

G. M. Gorbunov, I. A. Lepshinskiy, and V. B. Rutovskiy *In its* Invest. of the Working Process in the Combust. Chambers of Gas-Turbine Eng. 7 Mar. 1967 p 1–17 refs (See N67-32348 18-28)

Previous experiments have shown that it is possible to set up regimes in which the combustion zone is located at the wall of the combustion chamber rather than in the central section as in conventional regimes. Such a regime was studied in chambers with and without vaned inserts by obtaining profiles of the temperatures, liquid and vaporized fuel concentrations, and flow velocities. It was found that in this regime, combustion of the annular air layer containing fuel vapors and droplets starts from the outer surface of the layer which is not adjacent to the recirculation zone. This situation appears to be favorable for obtaining improved temperature profiles at the chamber outlet. The flow resistance is also lower, since secondary air jets do not have to penetrate into the axial combustion region as is the case with a conventional location of the combustion zone. However, a tendency to oscillatory burning was observed. Author

N67-32350# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ON THE STRUCTURE OF CIRCULATING MOTION IN A GTE CHAMBER [K STROYENIYU TSIRKULYATSIONNOGO TECHENIYA V KAMERE GTD]

L. A. Kvasnikov *In its* Invest. of the Working Process in the Combust. Chambers of Gas-Turbine Eng. 7 Mar. 1967 p 19–29 refs (See N67-32348 18-28)

To evaluate the interaction between the main and recirculation flows, with pressure variations along the streamlines taken into consideration, a model of the gas flow in the recirculation zone of a gas turbine combustion chamber was developed. According to this model, the flow structure in the initial chamber section is determined by the formation of an annular vortex of the recirculation stream. The latter is deformed by the main stream flowing between the annular vortex and the chamber wall. The general principle of the method for calculating the velocity profiles, pressure profiles, turbulence characteristics, and boundaries between the main and recirculation flows are discussed. Preliminary results indicate good agreement between calculated and experimental data. Author

N67-32351# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THE MECHANISM OF BURNING A FUEL-AIR MIXTURE IN A GTE CHAMBER UNDER CONDITIONS OF MAXIMUM LEANING [MEKHANIZM GORENIYA TOPLIVO–VOZDUSHNOY SMESI V KAMERE GTD NA REZHIMAKH PREDEL'NOGO OBEDNENIYA]

S. I. Shakhurin *In its* Invest. of the Working Process in the Combust. Chambers of Gas-Turbine Eng. 7 Mar. 1967 p 31–49 refs (See N67-32348 18-28)

Experiments with an aviation gas turbine combustion chamber model were conducted in order to study combustion and flame stabilization at the maximum permissible air–fuel ratio under high-altitude conditions. In the experiments, conducted at 0.5–1.5 kg/cm^2, the location of the flame front, the gas dynamic flow structure, and the mechanism of fuel injection were determined in regimes ranging from design conditions to conditions with maximum excess of air. Axial velocity fields, local temperature fields, the position of the flame front, and local fuel concentrations were measured at varying fuel–air ratios and pressures. The results showed that the temperature profiles with maxima of 1200–1600 K were almost identical for all air–fuel ratios and pressures. At the maximum air–fuel ratio (overall air-excess factor = 160) the combustion zone was found to be located in the flow recirculation zone where the fresh fuel-air mixture entered along the flow lines. The flow structure was not affected by changes in pressure or air velocity. Author

N67-32352# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE CHARACTERISTICS OF GTE COMBUSTION CHAMBERS IN REGIMES OF MAXIMUM PERMISSIBLE LEANING UNDER HIGH-ALTITUDE CONDITIONS [ISSLEDOVANIYE KHARAKTERISTIK KAMER SGORANIYA GTD NA REZHIMAKH PREDEL'NO DOPUSTIMOGO OBEDNENIYA V VYSOTNYKH USLOVIYAKH]

S. I. Shakhurin *In its* Invest. of the Working Process in the Combust. Chambers of Gas-Turbine Eng. 7 Mar. 1967 p 51–72 refs (See N67-32348 18-28)

Experiments have been made to determine the conditions which will widen the range of stable engine operation at high altitudes. The experiments were conducted with a model of an aviation turbine combustion chamber. The inlet air (1.4 kg/sec) was preheated to 550K. The chamber was connected with an ejector permitting operation at 0.5–1.5 atm pressure. The air to the ejector was preheated to 800–1000K by heat exchange with the combustion products. Vaned flow turbulizers with and without holes in the central disk and two types of swirl atomizers were used. During the experiments the fuel injection rate was lowered until blow-off occurred, at which point the fuel consumption, air pressure, and temperature were measured. The results showed that an increase in the chamber pressure increases the combustion efficiency and considerable widens the range of stable operation with lean mixtures. The stability range increased substantially when the atomization was improved and the holes in the turbulizer disk were blocked. Atomizers securing a sufficiently large spray angle at minimum fuel-injection rates improved stability. Author

N67-32380 Technische Hochschule in Graz (Austria).

SPECIAL PROBLEMS OF HEAT TRANSFER IN TURBULENT TUBE FLOW [SONDERPROBLEME DES WAERMEUEBERGANGES BEI TURBULENTER ROHRSTROEMUNG]

Ernst Toplak (Ph.D. Thesis) 1966 57 p refs In GERMAN

An attempt was made to provide a basis for calculating heat transfer in tubes with rectangular or square profiles carrying a flow of hot air. Considered was a tube on which three sides were kept at a constant temperature by cooling, while the fourth side was insulated. Heat flux values in the wall of a tube carrying a hot air flow were also determined in axial direction at the beginning and at the end of the cooled section. Analytical calculations were made under simplifying assumptions. Experiments were conducted to obtain values for the heat transfer on the cooled and on the insulated walls. The investigations included the introduction of a separating wall into the tubes by which the tube profile was divided into two equal ducts. The hydrodynamic processes caused by a right-angled front plate at the inlet of a circular pipe were also experimentally studied. Transl. by K.W.

N67-32465# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

HEAT TRANSFER AND EQUILIBRIUM TEMPERATURE OF A SPHERE IN A SUPERSONIC FLOW OF RAREFIED GAS

Yu. A. Koshmarov and N. M. Gorskaya 24 Apr. 1967 9 p refs Transl. into ENGLISH from Izv. Acad. Nauk SSSR, Mekhan. Zhidkosti i Gaza (USSR), no. 4, 1966 p 175–177
(Contract NOw-62-0204-c)
(TG-230-T522; AD-652820) CFSTI: HC $3.00/MF $0.65

The results of experimental investigations of the equilibrium temperature and heat transfer of a sphere in a supersonic rarefied air flow are discussed. The experiments were performed in an evacuated wind tunnel; the working flows were produced by three conical nozzles. The equilibrium temperature of the sphere was

measured by the stationary method. The model was kept in the flow until its temperature stopped varying with time. The mean heat-transfer coefficients were measured by the non-steady-state method. The results are shown in graphic form. Author (TAB)

N67-32476# Denver Research Inst., Colo.
BLACK BODY FUNCTIONS FOR PYROTECHNICISTS
R. M. Blunt. Crane, Ind., Naval Ammunition Depot, Mar. 1967 193 p ref
(Contract N164-11171)
(RDTR-90; AD-652822) CFSTI: HC $3.00/MF $0.65

Planck's black body data is tabulated. The data is presented from 0.35 microns to 12.0 microns in increments of 0.005 microns and at temperatures from 1500K through 4050K in 50K increments. Hemispherical power, power normalized to peak, spectral brightness, temperature exponent M, and cumulative and percentage of power between zero and the listed wavelength. In addition, graphs of the temperature exponent vs temperature and vs wavelength are included. Author (TAB)

N67-32560*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ACTIVATION, GROWTH, AND DETACHMENT OF BOILING BUBBLES IN WATER FROM ARTIFICIAL NUCLEATION SITES OF KNOWN GEOMETRY AND SIZE
John R. Howell and Robert Siegel. Washington, NASA, Aug. 1967 43 p refs
(NASA-TN-D-4101) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Artificial nucleation sites in the range from 0.0015 to 0.032 inch in radius were drilled in a polished metal surface by either electron-beam or mechanical drilling. The formation of boiling bubbles was studied by electrically heating the surface in saturated distilled water and by obtaining surface temperature, heat flux, and photographic data. The surface-temperature elevation above saturation required to produce ebullition from a pre-existing vapor nucleus is given as a function of site radius. The results are compared with several available analyses including one proposed in the present report. The analyses do not compare well with the data, thus a basic feature is still missing from the analytical models. In general, the analyses predict that bubbles will start to grow at surface temperatures lower than those measured experimentally. Data giving bubble growth as a function of site radius and surface temperature elevation are provided for saturated water and are compared with theoretical growth relations. At bubble detachment in saturated liquid, the buoyancy and surface-tension forces are found to be approximately equal. Author

N67-32628# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LUMINOUS ZONE PROPAGATION AT AN ELECTRIC EXPLOSION IN HEAVY WIRES
V. M. Kulgavchuk. *In its* J. of Appl. Mech. and Tech. Phys. 5 Dec. 1966 p 19-26 refs (See N67-32626 18-34)

Experiments were conducted to establish the principles of luminous zone propagation at an explosion and the energy of hydrodynamic motion when transmitting diverse energies to a wire under conditions most closely approaching the idea of instantaneous input. The explosion procedure was used with a break in the current, and gauging the energy led into the wire at the moment the break started. For comparison, an experiment was also made without a break in the current. Copper wires, 0.74 mm in diameter and 20 cm long, were used. Experimental conclusions demonstrate that the time relation of luminous zone diameter coincides with the principle of motion in a self-modeling cylindrical shock wave. It is also shown that the effective energy lead-in time is close to the vaporization time (1.4 mcsec); in the comparison experiment, the time is considerably larger (about 8 mcsec). M.G.J.

N67-32683# Brown Univ., Providence, R. I. Div. of Engineering.
NUMERICAL SOLUTIONS FOR RADIATING HYPERVELOCITY BOUNDARY LAYER FLOW ON A FLAT PLATE
Merwin Sibulkin, and Jean-Claude Dispaux. Mar. 1967 49 p refs
(Contract Nonr-562(35))
(AD-652365) CFSTI: HC $3.00/MF $0.65

The effects of thermal radiation on laminar, flat plate boundary layer flow have been investigated. Non-similar velocity and temperature profiles were obtained as numerical solutions of an appropriate set of finite difference equations. Simplified expressions for the thermodynamic and transport properties were used together with a mean radiation absorption coefficient approximating that of air. On the basis of the results of a previous approximate analysis, it was assumed that the boundary layer would be optically thin; for the velocity range considered (10 to 40 km/s) the numerical results confirmed this hypothesis. It was found that the maximum temperatures in the radiating boundary layers were much lower than in the corresponding non-radiating cases and that the radiating boundary layers were much thinner. Changing the exponent in the temperature-viscosity relationship mu proportional to T to the omega power from 1.0 to .75 had a negligible effect on the maximum temperature in the boundary layer but caused a significant reduction in its thickness and thus in the radiative heat flux to the wall. The predictions of the approximate analysis were compared with the numerical results and found to give useful engineering estimates of the properties of radiating boundary layers. Author (TAB)

N67-32685# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
RADIATION TRANSFER IN SPECTRAL LINES
L. M. Biberman. 22 Mar. 1966 22 p refs Transl. into ENGLISH of the publ. "Perenos Izlucheniya v Spektral'nykh Liniyakh" Moscow, Mosk. Energ. Inst., 1965 p 1-16
(FTD-MT-65-531; TT-67-72020; AD-652476) CFSTI: HC $3.00/MF $0.65

A discussion is given of the basic results of contemporary theory of radiation transfer in spectral lines, its experimental foundation, and certain applications to the properties, kinetics, and diagnostics of plasma. TAB

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-31547# Office of Aerospace Research, Historical Div.
SCIENCE AND THE AIR FORCE. A HISTORY OF THE AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Nick A. Komons. 1966 181 p refs
(OAR-66-7; AD-649855) CFSTI: HC $3.00/MF $0.65

Contents: Organizing for Research; The Haywood Years; OSR and the Federal Science Scene; Center Status; The Conundrum of Funding; Crisis in Research Management; An Exercise in Austerity; Project Far Side; Creation of the Air Force Research Division; From AFRD to OAR; The Millsaps Years. TAB

N67-31583*# Massachusetts Inst. of Tech., Cambridge. Alfred P. Sloan School of Management.
THE MEASUREMENT AND IMPROVEMENT OF R&D MARKETING EFFECTIVENESS

Edward B. Roberts Jan. 1967 18 p ref Presented at the 5th Ann. Management Conf. on Marketing in the Defense Ind., Boston, 19 May 1966; sponsored by Defense Marketing Group, Am. Marketing Assoc., and Bur. of Business Res.
(Grant NsG-235)
(NASA-CR-85971; Rept.-235-66) CFSTI: HC $3.00/MF $0.65 CSCL 05A

Reviewed are initially the results of studies made of two Department of Defense field centers in which a total of 90 R&D contract awards above $100,000 in size were examined. The differences between winners and losers on the same sets of R&D competition are pointed out. To measure R&D marketing effectiveness, a series of comparative analyses were made of the strategies of nine companies located along the eastern seaboard ranging in size from several millions of dollars in sales to several hundred million dollars. A total of 121 competitions were studied. Analyzed were the numeric contract capture ratio, the dollar capture ratio, and the return on proposal investment. A major finding of the study is that the winners in competitive bidding are usually those companies that have done sufficient work with the government technical initiator of R&D procurement to be listed first or second on his suggested source list. Measures to improve the R&D marketing effectiveness include improved marketing analyses, more integrated funding and decision making, logic and rationality in binding, concentration on the early phases of the competition, and orientation of a company's engineering staff toward marketing.
K.W.

N67-31640*# Northwestern Univ., Evanston, Ill. Dept. of Geography.
SPATIAL DATA SYSTEMS: SYSTEMS CONSIDERATIONS
Kenneth J. Dueker Dec. 1966 78 p refs
(Grant NGR-14-007-027; Contract Nonr-1228(37))
(NASA-CR-85627; TR-5) CSCL 05B

The greater speeds and storage capacities of newer computers requires new concepts of data organization and new means to create and access these more complex data structures. Of particular concern in urban and transportation planning are needs to link separately collected data that relate to the same phenomena or spatial locations, and a need for user-oriented data handling capabilities. These needs are explored and recommendations are made. This volume deals with entity linkage, organization of data for retrieval, search efficiencies, point in polygon procedures and retrieval from digitized imagery.
Author

N67-31668# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 5 Monthly Review of Selected Foreign Scientific and Technical Literature
May 1967 148 p refs

CONTENTS:

1. UNSTEADY MOTION OF COMPRESSIBLE MEDIA WITH BLAST WAVES I. Soukhanov p 1–10 refs (See N67-31667 18-12)

2. HYDROCARBON-UTILIZING MICROORGANISMS L. Perkins p 11–19 refs (See N67-31668 18-04)

3. DIFFUSION THEORY OF ADHESION AND ITS APPLICATION TO BONDING OF PLASTICIZED ELASTOMERS B. Obrossimow p 20–30 refs (See N67-31669 18-06)

4. RESEARCH PROGRESS ON RARE EARTH ELEMENT CHALCOGENIDES J. G. Kourilo p 31–49 refs (See N67-31670 18-06)

N67-31672# Library of Congress, Washington, D. C. Aerospace Technology Div.
FOREIGN SCIENCE BULLETIN, VOLUME 3, NO. 4 Monthly Review of Selected Foreign Scientific and Technical Literature
Apr. 1967 122 p refs

CONTENTS:

1. SPACECRAFT CABIN ATMOSPHERES. A REVIEW OF SOVIET LITERATURE B. Mandrovsky p 1–37 refs (See N67-31673 18-31)

2. RECENT SOVIET RESEARCH ON TROPOSPHERIC COMMUNICATIONS B. Doncov p 38–51 refs (See N67-31674 18-13)

3. FIBER-OPTICS LASER WITH NONRESONANT FEEDBACK Y. Ksander p 52–57 refs (See N67-31675 18-16)

4. THERMAL AND THERMAL-OXIDATIVE DEGRADATION OF SOME HEAT-RESISTANT POLYMERS B. Nartsissov p 58–68 refs (See N67-31676 18-18)

5. BIOLOGICALLY ACTIVE ORGANOTIN AND ORGANOLEAD COMPOUNDS AND POLYMERIC MATERIALS B. Markov p 69–87 refs (See N67-31677 18-06)

N67-32152*# Washington Univ., St. Louis, Mo. Dept. of Economics.
PROSPECTS FOR THE AMERICAN ECONOMY DURING THE POST-VIETNAM PERIOD
Murray L. Weidenbaum Jul. 1967 48 p refs *Its* Working Paper 6709
(Grant NsG-342)
(NASA-CR-86617) CSCL 05C

Major types of options that are available to economic policy makers in the U.S. during the coming decade are outlined. The study indicates the substantial amount of public resources and revenues likely to be available in the years following the termination of hostilities in Vietnam. It is intended to be helpful to policy-makers concerned with future developments in the national space program. A set of long-range economic projections prepared by the Department of Commerce was utilized to indicate the possible magnitude of economic growth. The purpose of the analysis is to provide an analytical background useful to those participating in economic policy decisions.
B.F.

N67-32175# RAND Corp., Santa Monica, Calif.
THE COST OF BASIC SCIENTIFIC RESEARCH IN EUROPE: DEPARTMENT OF DEFENSE EXPERIENCE 1956–1966
E. D. Brunner Apr. 1967 57 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5275-PR; AD-653177) CFSTI: HC $3.00/MF $0.65

An analysis is presented of the cost of basic scientific research obtained in Europe and Israel from 1956 through 1966 by agencies of the Department of Defense. Cost-sharing agreements with European institutions and grants have prevented the average cost of research agreements from rising between 1961-1962 and 1965-1966. In the case of non-cost-sharing agreements, however, the cost has increased throughout the entire period. An analysis of the average cost per scientist per man-month for all types of research reveals that the cost of basic research obtained in the United States ranged from three to four times the cost in Europe.
Author (TAB)

N67-32214# Institute for Defense Analyses, Arlington, Va. Economic and Political Studies Div.
DEMAND ANALYSIS FOR AIR TRAVEL BY SUPERSONIC TRANSPORT, VOLUME I
Norman J. Asher, William F. Bezazr, William A. Cox, Richard F. Muth, and Walter Oi Dec. 1966 115 p ref
(Contract FA-SS-66-14)
(R-118, Vol. I; AD-652309) CFSTI: HC $3.00/MF $0.65

The Report projects to 1990 the potential demand for a US SST in competition with the British-French Concorde, and examines the effects on the US balance of payments of these projections and the resulting international fleet mixes. The analysis is in three parts: (1) Passenger demand is projected by first estimating the total demand for air travel in terms of revenue passenger miles and then the extent of passenger preference for supersonic over subsonic travel. (2) Passenger demand is converted

into aircraft demand and fleet mixes under various assumptions as to boom restriction, passenger valuation of travel time, and fares; and international fleet mixes are determined. (3) The US balance-of-payments implications of these aircraft and travel demands are then projected. Results are, in general, presented for a variety of conditions intended to bracket the range of possibilities.
Author (TAB)

N67-32215*# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
[CRUFT LABORATORY] Semiannual Progress Report, 1 Jul.–31 Dec. 1966
Mar. 1967 89 p refs
(Grants NsG-579; NGR-22-007-056; NGR-22-007-068; Contracts Nonr-1866(16); Nonr-1866(07) et al)
(NASA-CR-85887; SAPR-73; AD-651121) CFSTI: HC $3.00/MF $0.65 CSCL 09C

CONTENTS:

1. VERY LOW FREQUENCY PROPAGATION J. A. Pierce 8 p (See N67-32216 18-21)

2. ELECTRON AND SOLID STATE PHYSICS H. Brooks, N. Bloembergen, P. S. Pershan, G. D. Boyd, G. E. Durand et al 12 p refs (See N67-32217 18-26)

3. AUTOMATIC CONTROL A. E. Bryson, Jr., R. E. Kronauer, Y. C. Ho, A. R. Dobell, K. J. Bullock et al 11 p refs (See N67-32218 18-10)

4. COMMUNICATIONS AND NETWORKS D. W. Tufts, A. A. Pandiscio, P. J. Trafton, H. Gish, and J. Proakis 8 p refs (See N67-32219 18-07)

5. MICROWAVE APPLICATION OF FERROMAGNETIC AND FERROELECTRIC MATERIALS R. V. Jones, R. Bartkowski, P. Berger, B. Levine, F. A. Milton et al 7 p refs (See N67-32220 18-26)

6. ELECTROMAGNETIC PHENOMENA R. W. P. King, T. T. Wu, B. Ramo Rao, C. L. Chen, K. Tizuka et al 7 p refs (See N67-32221 18-07)

N67-32273# Illinois Univ., Urbana. Coordinated Science Lab.
ON CLUSTERING TECHNIQUES OF CITATION GRAPHS
F. P. Preparata and R. T. Chien May 1967 25 p refs
(Contract DA-28-043-AMC-00073(E); Grant NSF GK-690)
(R-349; AD-652593) CFSTI: HC $3.00/MF $0.65

The study is an application of graph theory to the problem of clustering in document retrieval systems using bibliographic coupling devices. The problem is attacked by mapping the citation graph of the document collection into a unidimensional storage array. The figure of merit of the location assignment is the total distance between connected pairs of documents, or, equivalently, the 'stretching' resulting from the mapping. This is the objective function of the problem. An algorithm is then presented for the reduction of the objective function, which provides a currently improving solution. Its computational complexity only grows as N3/2, where n is the collection size.
Author (TAB)

N67-32281 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
JOURNAL OF ENGINEERING PHYSICS Selected Articles
17 Mar. 1967 73 p refs Transl. into ENGLISH from Inzh.-Fiz. Zh. (USSR), v. 7, no. 9, 1964 p 25–29, 38–43, 64–77, 83–91, 102–107
(FTD-MT-65-329; TT-67-61680; AD-651090) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. CALCULATION OF PROCESS OF EVACUATION OF A GAS VOLUME N. P. Belik, N. M. Belyayev, and G. S. Shandorov p 1–8 refs (See N67-32282 18-33)

2. HEAT EXCHANGE BETWEEN A MOVING DISPERSED MEDIUM AND THE WALL OF A PIPE V. I. Malyukevich p 9–17 refs (See N67-32283 18-33)

3. NON-STATIONARY PROBLEMS OF THERMOELASTICITY FOR A PLATE AND A CYLINDRICAL SHELL V. F. Kolesov p 19–27 refs (See N67-32284 18-32)

4. SOLUTION OF NON-HOMOGENEOUS EQUATION OF THERMAL CONDUCTION FOR MULTILAYERED BODIES P. Ye. Bulavin and V. M. Kashcheyev p 29–37 refs (See N67-32285 18-33)

5. BLOCK DIAGRAMS OF MEASUREMENTS OF PARAMETERS OF FLOWS WITH THE HELP OF THERMISTORS A. G. Shashkov p 39–46 refs (See N67-32286 18-12)

6. INFLUENCE OF TEMPERATURE CONDITIONS ON STABILITY OF ROTATIONAL MOTION OF A LIQUID S. K. Aslanov p 47–52 ref (See N67-32287 18-12)

7. CONCERNING THE USE OF TWO-PHASE SYSTEMS AS A THERMODYNAMIC WORKING MEDIUM I. T. El'perin and V. A. Minkov p 53–62 refs (See N67-32288 18-03)

N67-32306# Science Communication, Inc., Washington, D. C.
CHEMICAL DATA COMPILATION ANALYSIS SURVEY Final Report
R. G. Brunner, B. K. Farris, S. I. Jover, and D. O. Myatt 20 Mar. 1967 154 p refs
(Grant NSF C-478)
(AD-652742) CFSTI: HC $3.00/MF $0.65

A major objective of the study is the development and application of a methodology for analysis and characterization of chemical data compilation activities. The basic analysis technique tested was the examination of each data compilation as a data file and its substance and property coverage. However, because of the complex interactions which exist between a data compilation activity and the environment on which it is operated and the technical activity which it supports, the study also examined operating statistics, operating motives, users served and other factors that might shed light on basic design factors. Emphasis was placed upon obtaining a greater amount of information relevant to the design elements associated with the actual development of a national chemical information system.
Author (TAB)

N67-32361* Chicago Univ., Ill.
SOME DETERMINANTS OF ORGANIZATIONAL SUCCESS
Frank Stafford (Mich. Univ.) and Selwyn W. Becker [1967] 15 p refs
(Grant NsG-370)
(NASA-CR-86985) CFSTI: $3.00 CSCL 05K

Measurements of the relative effect on organization efficiency of variables frequently utilized by psychologists, economists, and sociologists are made. To what extent variance in organizational efficiency can be explained by organization size, adoption of innovations, psychological distance in the management team, administrative size, and the state of the organization's surrounding environment is investigated.
Author

N67-32373*# Wayne State Univ., Detroit, Mich. Div. of Urban Extension.
THE TRANSFER OF NASA TECHNOLOGY TO OTHER FEDERAL AGENCIES Interim Progress Report, 21 Dec. 1966–21 Mar. 1967
[1967] 67 p
(Contract NSR-23-006-037)
(NASA-CR-86984) CSCL 05B

An experimental program to apply aerospace-related science and technology to current law enforcement programs is described in terms of goals and current achievements. Police departments in Philadelphia, St. Louis, New York, and California are discussed as participants in the NASA supported program. The following

examples of applications are described: communications helmet, a motion detection system, and a lenticular stereoscopic television. S.P.

N67-32397# Congress. Senate. Committee on Aeronautical and Space Sciences.
NASA AUTHORIZATION FOR FISCAL YEAR 1968
Washington, GPO, 1967 109 p Rept. of the Comm. on Aeron. and Space Sci. on S. 1296, 90th Congr., 1st Sess.
(Rept.-353)

Congressional adjustments to the NASA fiscal year 1968 request for funds are listed, along with a summary of the various projects for which funds are requested. These include Apollo Project and its applications, advanced missions, lunar and planetary explorations, research on various space vehicle systems and human factors, nuclear rockets, tracking and data acquisition, the sustaining university program, and technology utilization. In addition to research and development projects, funds are requested for the construction of facility additions and for administrative operations. Space programs of other agencies are noted. M.W.R.

N67-32477*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
AUTOMATION IN LIBRARIES (FIRST ATLIS WORKSHOP)
Redstone Arsenal, Ala., Redstone Sci. Inform. Center, Jun. 1967 196 p Meeting held at Redstone Arsenal, Ala., 15–17 Nov. 1966; Sponsored by Army Tech. Library *Its* Army Tech. Library Rept.-13 Joint report with Army Missile Command
(NASA-TM-X-60094; RSIC-625) CSCL 05B

The four major areas covered are: general systems, current dissemination programs, retrospective searching, and on-line applications. General systems are exemplified by a description of the system ALPHA (Automated Literature Processing, Handling and Analysis) that covers control, book ordering and receiving, cataloging, circulation, and serialization. The topics on current dissemination programs include summaries of Selective Dissemination of Information (SDI) programs, and a breakdown of NASA/SDI user reaction data. Retrospective searching is discussed as it is practiced at the Defense Documentation Center, at the Redstone Scientific Information Center, and at the NASA Scientific and Technical Information Division. On-line applications are concerned with the ALPHA 2 system, which is an extension and modification of the ALPHA system concepts, and with the NAPALM project (National ADP Program for Army Material Command Logistics Management). A panel discussion on systems and techniques concludes this presentation. K.W.

N67-32632# RAND Corp., Santa Monica, Calif
THE FUTURE OF SCIENCE
Olaf Helmer May 1967 17 p refs Submitted for publication
(P-3607; AD-653176) CFSTI: HC $3.00/MF $0.65

The future of science is discussed in terms of (1) the size of the scientific establishment; (2) attitudes toward the future; (3) changes in research methods; (4) new forms of procedures: conferences; research-computer symbiosis; interdisciplinary teams; university reform; publications; and the popularization of science; (5) future developments and breakthroughs. TAB

N67-32557*# California Univ., Berkeley. Space Sciences Lab.
TECHNOLOGY AND URBAN MANAGEMENT Semiannual Report, 1 Oct. 1966–31 Mar. 1967
C. W. Churchman and M. M. Webber 31 Mar. 1967 38 p refs *Its* Space Sci. Lab. Ser. No. 8, Issue No. 28
(Grant NGR-05-003-125)
(NASA-CR-86664) CSCL 05C

Reported is the initiation of a study designed to explore the opportunities that might be latent within the newly emerging technologies. The study was undertaken in an effort to deal with critical problems of the city as: (1) the declining proportion of total employment contributed by manufacturing and unskilled operations and the rise of the service occupations; and (2) the declining opportunities for employment, skills, improvements and acculturation into modern society of rural migrants. Discussed are joint efforts of NASA, the University of California, the city of Oakland, and the Ford Foundation which focus on alleviating these problems created primarily by the inability of contemporary urban society and the city to adapt to changes induced by science and new technological innovations. S.C.W.

N67-32566*# Texas A&M Univ., College Station. Graduate Coll.
AN OPTIMIZATION PROCEDURE FOR NETWORK PLANNING SYSTEMS
Orlando Sia Madrigal (M.S. Thesis) May 1967 102 p refs
(Contract NAS9-4318)
(NASA-CR-65644) CFSTI: HC $3.00/MF $0.65 CSCL 05A

A time compression algorithm for the critical path method of planning and controlling large management projects is evaluated and a computer program developed that eliminates the necessity of enumerating all possible combinations for time compression in cases where more than one critical path exists in a network. The present state of the development computer program is only applicable to medium-sized projects. The total projection duration has an associated cost function dual to the activity cost function; the routine depends upon the time interval used in compression. G.G.

N67-32603*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
ULTEK TRIP REPORT
In its Radiometry Progr. 1st Trimester, 1967 Apr. 1967 4 p
(See N67-32594 18-23)

A trip to a contractor demonstrated the desirability, if not feasibility, to check out all major and/or important equipment before shipment from the vendor's facility takes place. Experiences are noted with regard to checkout of ultrahigh vacuum systems, and the delays and difficulties on the part of the vendor are reported. M.W.R.

N67-32826# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
JOURNAL OF APPLIED MECHANICS AND TECHNICAL PHYSICS Selected Articles
5 Dec. 1966 32 p refs Transl. into ENGLISH from Zh. Prikl. Mekhan. i Tekhn. Fiz. (Moscow), no. 4, 1965 p 10–20; 165–168
(FTD-HT-66-455; AD-648882) CFSTI: HC $3.00/MF $0.65

CONTENTS:

1. ELECTRON RECOMBINATION IN A PLASMA EXPANDING IN A VACUUM N. M. Kuznetsov and Yu. P. Raizer p 1–19 refs (See N67-32627 18-25)

2. LUMINOUS ZONE PROPAGATION AT AN ELECTRIC EXPLOSION IN HEAVY WIRES V. M. Kulgavchuk p 19–28 refs (See N67-32628 18-33)

N67-32864# RAND Corp., Santa Monica, Calif.
A SIMPLE SCHEME FOR FORMALIZING DATA RETRIEVAL REQUESTS

Fred M. Tonge May 1967 37 p refs
(Contract F44620-67-C-0045)
(RM-5150-PR: AD-652201) CFSTI: HC $3.00/MF $0.65

The memorandum discusses an experimental scheme for translation of data retrieval requests, expressed in reasonable natural language, into a formalized format. The intent of the translation procedure described is to provide a rudimentary query system that will give the information analyst access to a computer-based data file without recourse to specialized computer jargon or knowledge of details of file organization. This access is provided through a simple translation procedure that immediately feeds its proposed translation back to the analyst for modification or correction before data retrieval begins. Such a stripped down system depends on unsophisticated techniques and makes errors, but those errors are subject to review by the user analyst before retrieval begins. The described procedure uses rules depending upon the position of words in the request and simple semantic information about the class of words to produce a first translation. Several examples of the detailed application of these rules illustrate the operation of the procedure, as well as deficiencies of the present scheme. Author (TAB)

Collections of NASA Documents

NASA is depositing its technical documents and bibliographic tools in eleven Federal Regional Technical Report Centers. Each center, located in one of the organizations listed below is prepared to furnish the general public such services as personal reference, interlibrary loans, photocopy service, and assistance in obtaining retention copies of NASA documents.

California: University of California, Berkeley
Colorado: University of Colorado, Boulder
District of Columbia: Library of Congress
Georgia: Georgia Institute of Technology, Atlanta
Illinois: The John Crerar Library, Chicago
Massachusetts: Massachusetts Institute of Technology, Cambridge
Missouri: Linda Hall Library, Kansas City
New York: Columbia University, New York
Pennsylvania: Carnegie Library of Pittsburgh
Texas: Southern Methodist University, Dallas
Washington: University of Washington, Seattle

NASA publications are currently being forwarded to the public libraries in the cities listed below:

California: Los Angeles and San Diego
Colorado: Denver
Connecticut: Hartford
Massachusetts: Boston
Michigan: Detroit
Minnesota: St. Paul and Minneapolis
Missouri: Kansas City and St. Louis
New Jersey: Trenton
New York: Brooklyn, Buffalo, Rochester and New York
Ohio: Cleveland, Cincinnati, Dayton, Toledo and Akron
Oklahoma: Oklahoma City
Tennessee: Memphis
Texas: Fort Worth and Dallas
Washington: Seattle
Wisconsin: Milwaukee

In addition, NASA regularly sends its publications to the Enoch Pratt Free Library located in Baltimore, Maryland and the Wilmington Institute Free Library, Wilmington, Delaware.

An extensive collection of NASA and NASA-sponsored scientific and technical publications available to the public for reference purposes is maintained at the Technical Information Service, American Institute of Aeronautics and Astronautics, 750 Third Avenue, New York, New York 10017.

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

NASA SCIENTIFIC AND TECHNICAL PUBLICATIONS

TECHNICAL REPORTS: Scientific and technical information considered important, complete, and a lasting contribution to existing knowledge.

TECHNICAL NOTES: Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

TECHNICAL MEMORANDUMS: Information receiving limited distribution because of preliminary data, security classification, or other reasons.

CONTRACTOR REPORTS: Scientific and technical information generated under a NASA contract or grant and considered an important contribution to existing knowledge.

TECHNICAL TRANSLATIONS: Information published in a foreign language considered to merit NASA distribution in English.

SPECIAL PUBLICATIONS: Information derived from or of value to NASA activities. Publications include conference proceedings, monographs, data compilations, handbooks, sourcebooks, and special bibliographies.

TECHNOLOGY UTILIZATION PUBLICATIONS: Information on technology used by NASA that may be of particular interest in commercial and other non-aerospace applications. Publications include Tech Briefs, Technology Utilization Reports and Notes, and Technology Surveys.

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION DIVISION

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546